Of this issue more than 4000 copies were printed

The Welding Engineer

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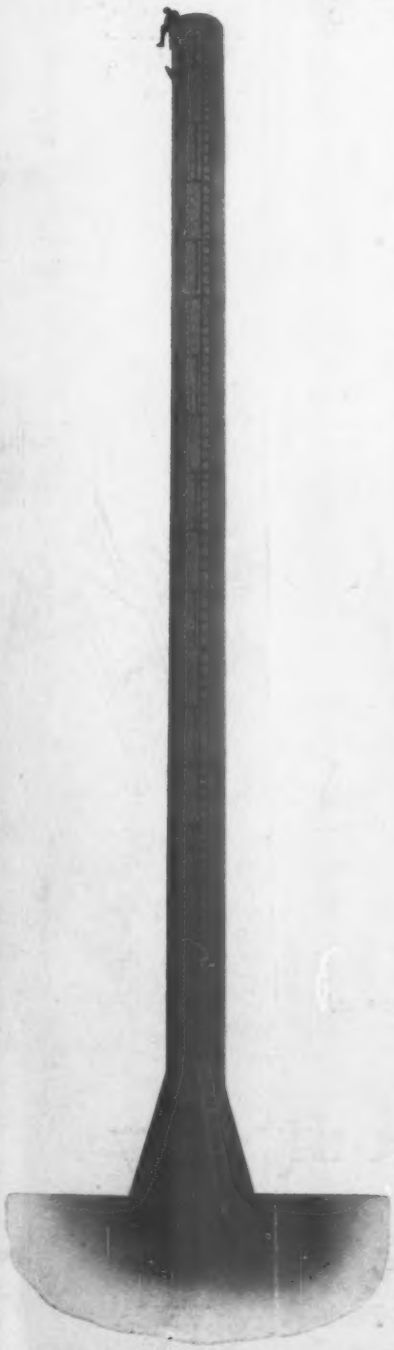

Steeple Jacks cutting down huge stack with oxy-acetylene apparatus

The Melting Pot

Welding by some one of the various processes is of vital importance in thousands of plants throughout this country. Factory managers are beginning to realize the adaptability and flexibility of the science of welding. It is cutting down manufacturing costs, minimizing the cost of expensive break-downs and cheating the junk pile.

Welding is a problem which should be studied earnestly by the factory manager. There are great possibilities—wonderful opportunities that should be taken advantage of.

The Welding Engineer is the faithful servant of the welding trade. Our ambition is to determine the highest and largest function of the field and then strive in every legitimate way to promote that function.

The Welding Engineer is an applicant for membership in the Audit Bureau of Circulations. That means we are "out in the open."

L. B. Mackenzie

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The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

Oxweld Equipment includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship, **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

Oxweld Supplies are made up in accordance with the formulae of our metallurgists—tested by analysis in our laboratory and their merits tested out and proven by our expert welders in actual shop practice. We guarantee **OXWELD SUPPLIES,** when used by competent welders, to produce better results than any others known to the art today.

Our knowledge and experience, as the largest makers of welding and cutting equipment in the world, are always at the service of every purchaser and prospective purchaser of **OXWELD APPARATUS,** to determine the most economical and efficient applications of the **PROCESS** to the manufacturing or repair problems at hand.

Write us for information on any class of Welding or Cutting Work

Oxweld Acetylene Company

CHICAGO
36th St. and Jasper Place

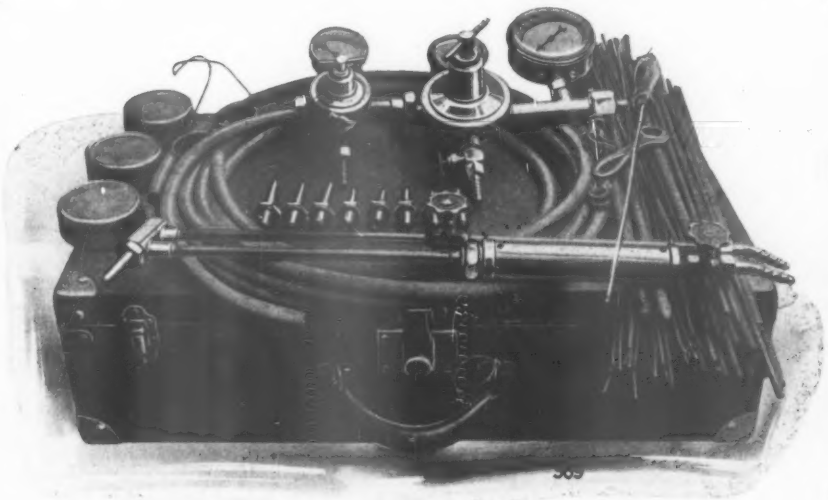
NEWARK, N. J.
6460-680 Frelinghuysen Ave.

LOS ANGELES
654-656 Pacific Electric Bldg.

The BUCKEYE Oxy-Acetylene Welding and Cutting Outfits

Stationary and Portable

We Build Preheating Kerosene Torches and Oil Furnaces



Live Men Wanted to Represent Us in Territory Not Allotted

Only Men Who Will Demonstrate Desired

We Build Both Oxygen as Well as Acetylene Generators

Ask for Catalog K

THE MACLEOD CO., East Pearl Street, CINCINNATI, OHIO

Mr. F. Hillix Cutting I-Beam.

What Users Say!

"Saved $200 in 5 hrs. Operated by a novice. No limit to its adaptability. Other welders became hot enough to pop out, but yours kept cool right up to the tip."
St. Joseph Valley Railway Co.

"We have tested your D-4 Outfit at cutting plate iron and steel and we are highly pleased with same."
F. O. Smith Shipbuilding Co.

"I have been using welding outfits for the past 2 years, but knew nothing of what a real welding torch was until I saw the Imperial torch. It has worked wonders for me."
Bean's Machine Shop.

Imperial Oxy-Acetylene
WELDING & CUTTING EQUIPMENT

"The first thing that impressed me was the exceptionally fine workmanship on your outfit—there is no cheap, unfinished look about the Imperial Torch. The non-back firing feature is based on sound engineering principles."
F. HILLIX, Instructor,
The Stout Institute, Menominee, Wis.

If you are looking for Efficiency, Safety and Economy we feel sure you cannot be disappointed in Imperial Equipment. Get our proposition before you decide.

The Imperial Brass Mfg. Co.

522 South Racine Avenue **CHICAGO**

Write for this FREE BOOK

Every Welder should have our new catalog No. 132, just off the press. Gives operating costs, views of work actually done and other valuable data.

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The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

ACETYLENE GENERATORS
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
International Oxygen Co.
The Macleod Co.
Oxweld Acetylene Co.
Vulcan Process Co., Inc.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Press Co.
Welding Materials.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

ANNEALING FURNACES
The Macleod Co.
Universal Oxygen Co.

APRONS (Asbestos)
Welding Materials.

ARC WELDERS
(See Electric Arc Welding Outfits)

ASBESTOS GLOVES
Welding Materials.

ASBESTOS SHEET PAPER
Davis-Bournonville Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

BLOW TORCHES (Acetylene)
Bermo Welding Apparatus Co.

BOOKS (Relating to Welding)
The Welding Engineer

BRASS AND BRONZE FLUX
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

BRASS SPELTER WIRE
Universal Oxygen Co.
Vulcan Process Co.

BRAZING OUTFITS
The Macleod Co.

BRONZE FILLER RODS
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

BUTT WELDERS (Electric Resistance)
Thomson Electric Welding Co
Welding Materials.

CARBIDE (Calcium)
American Carbolite Sales Co.
Union Carbide Co.
Canada Carbide Sales Co.

CARBON REMOVING OXYGEN
The Linde Air Products Co.
Universal Oxygen Co.

CARBON REMOVING TORCHES
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Macleod Co
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

CAST IRON FILLER RODS
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

CAST IRON FLUX
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

CUTTING (Oxygen for)
International Oxygen Co.
The Linde Air Products Co.
Universal Oxygen Co.

ELECTRIC ARC WELDING OUTFITS
Westinghouse Electric & Mfg. Co.
Welding Materials.

ELECTRIC RESISTANCE WELDING MACHINES
(See Spot, Butt and Seam Welders)
Thomson Electric Welding Co.

ELECTROLYTIC OXYGEN PLANTS
International Oxygen Co.
Universal Oxygen Co.

FILLER RODS (Aluminum)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

FILLER RODS (Bronze)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FILLER RODS (Manganese Bronze)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FILLER RODS (Swedish Iron)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FILLER RODS (Tobin Bronze)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FILLER RODS (Vanadium Steel)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FIREPROOF PLASTIC
Bermo Welding Apparatus Co.

FIREPROOF PLASTIC BINDER
Welding Materials.

FLUE WELDERS (Electric Resistance)
Thomson Electric Welding Co.

FLUX WELDERS (Electric)
Westinghouse Electric & Mfg. Co.

FURNACES (Annealing)
The Macleod Co.
Universal Oxygen Co.

FLUX (Aluminum)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

WELDING

There is more Davis-Bournonville Apparatus in general use for oxy-acetylene welding and cutting than of any other.

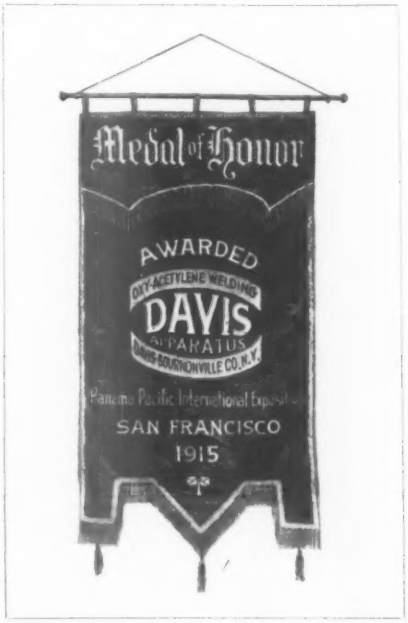
It has been in general, practical use for welding and cutting longer than any other in this country.

It is being used by metal workers for a greater variety of operations in manufacturing metal goods.

The largest foundries and steel mills in the country are using it for reclaiming defective castings, welding, steel cutting.

The largest locomotive and car-building shops are using it for welding and cutting on construction and repair work.

OXY-ACETYLENE WELDING
DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.



The Medal of Honor (higher award than the Gold Medal), the Highest Award for Oxy-Acetylene Apparatus at the Panama-Pacific Exposition, was awarded Davis Apparatus.

CUTTING

The largest ship-building and dry docks and all United States Navy Yards are using it for steel cutting and repairs.

The largest range boiler and steel tank manufacturers are welding their product with it.

The largest steel furniture, door, sash and frame makers employ it in manufacturing.

The largest automobile metal-body builders are using it extensively for welding.

The largest scrap yards are using it for cutting and wrecking.

Hundreds of small repair shops and garages are daily making profitable use of small outfits.

Concerns that have made oxy-acetylene welding and cutting the big success it is, installed "D-B" apparatus because they gave efficiency of the apparatus and the value to be obtained from it first consideration in selecting equipment—because it provides the widest range of equipment made for obtaining the full value of the oxy-acetylene process—because the long practical experience of the "D-B" Company in its own welding shops and development and demonstration departments made it possible for the company to be of practical service to its customers.

These are reasons that will have weight with the prospective purchaser of welding and cutting equipment, whether his requirements are small or great.

Full information, catalogs, bulletins and co-operative service in determining the customer's application of the process will be given on request.

Davis-Bournonville Company

NEW YORK CHICAGO

Address General Offices and Demonstration Plant, JERSEY CITY, N. J.

Sales Offices: New York, Chicago, Detroit, Cleveland, Pittsburgh, Philadelphia

General Dealers in New England, Southern and Western States

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FLUX (Cast Iron)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FLUX (Tobin Bronze)

GASOLINE PREHEATING FURNACES
The Prest-O-Lite Co., Inc.

GAS BURNERS (Preheating)
The Macleod Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.

GENERATORS (Acetylene)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
International Oxygen Co.
The Macleod Co.
Oxweld Acetylene Co.
Vulcan Process Co.

GLOVES (Asbestos)
Welding Materials.

GOGGLES AND HOODS (Welders)
William C. Adams.
Bermo Welding Apparatus Co.
Chicago Eye Shield Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Westinghouse Electric & Mfg. Co.
Welding Materials.

GLOVES (Welders Asbestos)
Davis-Bournonville Co.
Oxweld Acetylene Co.
Universal Oxygen Co.

GAUGES (Pressure)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
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Universal Oxygen Co.
U. S. Gauge Co.
Vulcan Process Co.

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Henderson-Willis Welding & Cutting Co.
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Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

HOSE UNIONS
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HYDROGEN
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Universal Oxygen Co.

KEROSENE PREHEATING TORCHES
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The Macleod Co.
Oxweld Acetylene Co.

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Henderson-Willis Welding & Cutting Co.
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Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding materials.

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The Ohio Electrolytic Oxygen Co.
The Logansport Oxygen Co.

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Oxweld Acetylene Co.
U. S. Gauge Co.
Universal Oxygen Co.
Vulcan Process Co.

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Henderson-Willis Welding & Cutting Co.
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International Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

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International Oxygen Co.
Universal Oxygen Co.

REGULATING VALVES (Oxygen)
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Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

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SEAM WELDERS (Electric Resistance)
Thomson Electric Welding Co.

SPELTER WIRE (Brass)

SPOT WELDERS (Electric Resistance)
Thomson Electric Welding Co.

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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding materials.

TANK CONNECTIONS (Oxygen and Acetylene Adaptors)

THERMIT WELDING
Goldschmidt-Thermit Co.

TOBIN BRONZE FILLER RODS
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

TORCHES (Gasoline and Kerosene Preheating)
The Macleod Co.
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Oxweld Acetylene Co.
Westinghouse Electric & Mfg. Co.

TORCHES (Oxy-Acetylene Cutting)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Macleod Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Acetylene Welding)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Macleod Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Hydrogen Cutting)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
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Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Hydrogen Welding)
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The Imperial Brass Mfg. Co.
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Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.
Vulcan Process Co.

VALVES (Acetylene Regulating)
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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

VALVES (For Acetylene Cylinders)
Commercial Acetylene Ry. Light & Signal Co.
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Universal Oxygen Co.

VALVES (For Oxygen Cylinders)
International Oxygen Co.
Universal Oxygen Co.

VALVES (Hydrogen Regulating)
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International Oxygen Co.
Universal Oxygen Co.

VALVES (Oxygen Regulating)
Bermo Welding Apparatus Co.
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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

VANADIUM STEEL FILLER RODS
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

WELDING (Electric Resistance-Custom Work)
Thomson Electric Welding Co.

WELDERS' GOGGLES
William C. Adams.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

WELDING MACHINES (Electric)
See Arc, Butt, Seam Welders.

WELDING (Oxygen for)
International Oxygen Co.
The Linde Air Products Co.
Universal Oxygen Co.

WELDING TORCHES (Oxy-Acetylene)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Macleod Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

WELDING TORCHES (Oxy-Hydrogen)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

LINDE OXYGEN

Service—Efficiency—Convenience—Economy

From Coast to Coast 39 Producing Plants and Distributing Stations provide an unlimited supply of LINDE OXYGEN for users everywhere.

PURITY

Linde Oxygen, made by the liquid-air process, is of the highest purity and efficiency. Exacting users demand Linde Oxygen, knowing they can obtain a uniformly pure gas, from a convenient source of supply, whether their requirements are large or small or vary from day to day.

SERVICE

Linde Oxygen is furnished in steel cylinders containing 100 and 200 cu. ft. respectively.

A large supply of charged cylinders is kept constantly on hand at all Distributing Stations, ready for immediate shipment.

LINDE SERVICE means no investment except for Oxygen actually received—no expensive overhead, or upkeep charges.

Linde Oxygen may be obtained direct from any of our Distributing Stations. Mail or 'phone your order to THE LINDE AIR PRODUCTS CO., at any of the following points:

ATLANTA, GA.
BALTIMORE, MD.
19 East Lombard Street
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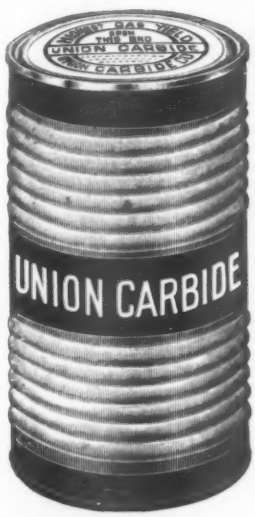

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CONTENTS

I. The Metals.—Iron, Platinum, Gold, Silver, Aluminum, Copper, Nickel, Welded Products. II. Electric Welding.—General, The La Grange-Hoho Process; The Zerener Electric Blowpipe; The Bernardos Arc-welding Process; The Slavianoff Arc-welding Process; Combination Slavianoff and Bernardos Processes; The Thomson Process. III. Hot-Flame Welding.—The Oxy-acetylene Process; The Oxy-hydrogen Process. IV. The Thermit Process. V. Miscellaneous Welding and Soldering Processes.—The Laffitte Welding Plate; The Ferrofix Brazing Process; Brazing and Soldering; The Blaugas Process; Glossary of Terms.

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Autogenous Welding and Cutting

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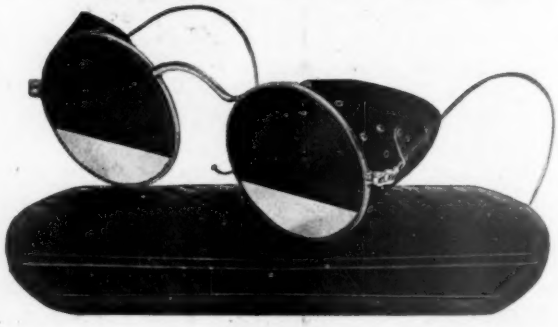

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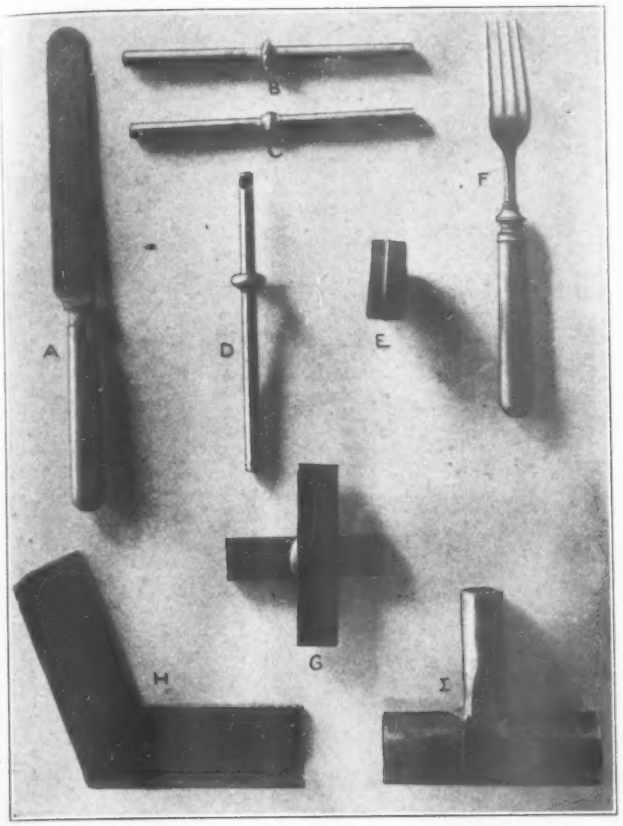

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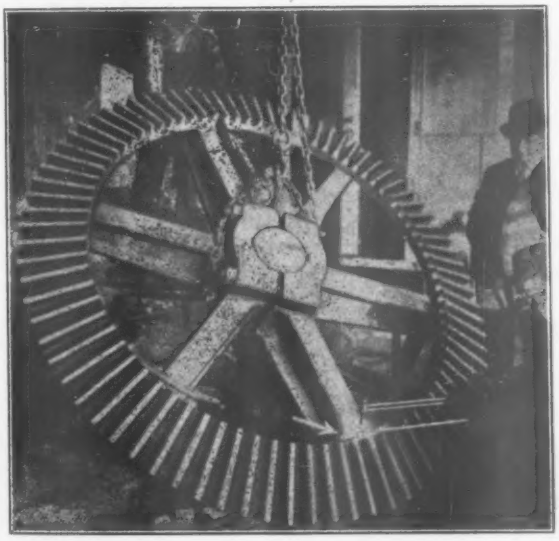
THOMSON ELECTRIC WELDING CO.
LYNN, MASS., U. S. A.

(a) Knife with hollow handle, steel blade.
(b) Flash weld in steel showing sharp fin.
(c) Showing smooth burr in steel wire.
(d) Upset collar on two rods.
(e) Caster, two halves of which have been welded.
(f) Welded bolster to hollow handle, German silver fork.
(g) Two pieces of steel welded.
(h) Oblique weld of angle iron.
(i) T weld—two sizes pipe.



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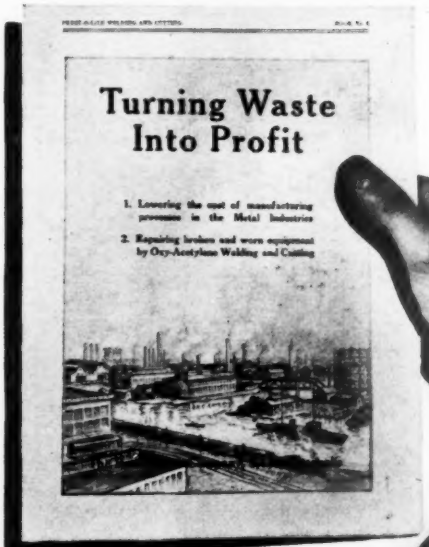
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We guarantee that of this issue more than 4,000 copies were printed, excluding copies spoiled in press room and bindery. At the time of mailing the known distribution was (actual count always exceeds press order):

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Copies to advertisers	41
Copies to prospective advertisers	12
Copies to other trade papers, correspondents, etc.	125
Copies mailed as samples to prospective subscribers	2,192
Copies retained at office of publication to fill new subscription orders, etc.	100
Copies for office use	10
TOTAL	4,000

VOLUME I. MARCH, 1916. NUMBER 3

The Business Situation

THERE is no slackening in the demand for goods or signs of weakness in the general business situation, although there is no little complaint of annoyances incidental to its rapid expansion. Nearly every line of industry is hampered by scarcity of supplies of some kind, and the whole situation is complicated by car shortage and congestion at the railway terminals. Prices are being pushed upward, but profits are uncertain to manufacturers unless they have covered their requirements for raw materials. The industries working upon war supplies have been drawing labor from other lines and affecting the entire wage situation. The rise of wages in the cities also attracts men from the farms and threatens to make the problem of agricultural help more acute.

In the welding industry there is much activity and manufacturers find it difficult to keep up with orders. Manufacturers of gas are experiencing trouble in securing tanks and users should facilitate matters as much as possible by returning empties promptly.

Pipe Connections

SEVERAL articles published elsewhere in this issue serve to illustrate the fact that welded pipe connections are stronger than ordinary pipe connections. In railroad service it has been found that welded pipe connections will increase the efficiency of a locomotive. Engine failures due to leaky or broken pipe connections are not uncommon, where threaded connections are used. It has been found, however, that welded connections not only result in increased service, but in a decrease in maintenance expense as well.

Many railroad shops equipped with welding apparatus are not employing the science of welding properly. This is true perhaps because of a mistrust of the process, as well as a lack of knowledge of what other shops are doing. More thought should be given to the extension of the welding work being done. It would pay the efficiency engineers of this country to take a practical course in welding.

Return Cylinders Promptly

WELDERS in the oxy-acetylene field can materially help the manufacturers of gas by returning empty cylinders promptly. The situation in the steel industry is such that gas manufacturers are finding it impossible to secure prompt delivery of new cylinders from cylinder manufacturers, and just when the difficulty will be removed is doubtful. Probably not while the war lasts. In the meantime users of gas should do as much as possible to co-operate with gas manufacturers.

Welding Work at Colleges

THE colleges are beginning to give particular attention to welding processes, and no doubt the future will bring us much interesting and instructive information from their engineering departments. In this issue there is published the result of an extensive and exhaustive test conducted by a prominent Western university, the subject of the test being the relative strength of welded and threaded pipe connections. Experimental reports as issued by the universities are usually very reliable and thorough and the report in question is very gratifying. It is to be hoped that more colleges will undertake experimental work in the welding field.

Taking Time by the Forelock

IT has been said that necessity is the mother of invention. This ancient proverb is illustrated in recent frantic attempts to conserve the supply of high-speed steel by welding processes. Until they are brought face to face with the necessity for action, American manufacturers are inclined to neglect their opportunities. The conservation of high-speed steel is only indicative of the many opportunities awaiting the thoughtful manufacturer who will study earnestly the adaptability of a welding process to his business.

Rules You Should Know

MR. CONREYE, special agent of the "bureau for the safe transportation of explosives and other dangerous articles," tells in an article in this issue how the consumer in the welding field may co-operate with the bureau and with the manufacturers of gas by complying with certain rules and regulations. For the benefit of everybody concerned we urge our readers to give this article attention.

Need of Text Books.

THERE would seem to be a need of a simple and reliable text book for welders. So far as we have been able to judge the very excellent books now in print have not been written with a view to furnishing elementary information for the operator. Instead they have been written from the standpoint of the chemist and the engineer, with the result that the man who seeks "first aid" from present text books is engulfed in a mass of technical data which he cannot understand and which is too vague and clouded to be of practical help. With this issue The Welding Engineer begins the publication of a series of articles, written by plain welders, and intended for the men who need this information. Later these articles will be re-edited and assembled in pamphlet form for distribution in the trade.

Test Reports of Oxy-Acetylene Welded Pipe Connections

By F. H. SIBLEY
Director Fowler Shops, University of Kansas

The rapid extension of the use of the oxy-acetylene blowpipe for welding pipe connections and the possibilities of still further adaptations in the future, give at this time particular interest to figures on the cost and efficiency of connections made by this process as compared to those of screwed connections.

During the spring of 1915 a series of experiments were conducted at the University of Kansas, which had for their purpose the determination of the strength of welded pipe connections. The pipe welds were compared with screwed connections of equal size and with the original pipe material The detail work of these experiments was performed by three senior students in Mechanical Engineering under the direction and supervision of the author.

The specimens were furnished by the Oxweld Acetylene Company, Chicago. The samples were cut from standard weight "National" black steel pipe, were from the same stock, and hence probably of uniform quality. The specimens included two pieces of the original pipe, four butt welds, two connections made with malleable iron screwed couplings, three welded tees and two tees made up with malleable iron screwed fittings.

The length of the straight samples was 18 inches. The pieces for the butt welds were cut at an angle of about 60 degrees (Fig. 1) in a pipe cutting machine to give the necessary "V" groove for welding.

The tees were made with an 18 inch run and a 15 inch outlet. The tee welds being made by cutting a hole in the run and butting the outlet against the outside of the run. All the connections were made by the Company's operator.

The straight samples of ½, ¾, 1 and 1½ inch pipe were fitted with plugs in the ends to prevent crushing in by the jaws of the testing machine and were then tested in tension by the usual method. The 2 inch straight samples were cut off square to lengths of 5 inches and tested in compression. For the tee welds a holder was made to fit the run of the tee at either side of the joint. The end of the holder was then placed in the upper jaws of the testing machine, the outlet of the tee was held in the lower jaws, and the sample was tested in tension.

The behavior of the welded connections under tension was very much like that of the original pipe specimens. Some of the specimens broke outside of the weld and some broke in the weld. All of the screwed connections broke right at the last thread in the fitting. The characteristics of these failures are shown in Figs. 2 and 3. The arrows indicate the location of the weld in the smaller samples.

The 2 inch pipe samples tested in compression bulged out

TABLE 1
DATA SHEET FOR TENSION TESTS
Standard Weight Steel Pipes
Butt Welded, Unwelded Pipe, and Screwed Couplings
Length of Specimens 18 Inches

Pipe Size (In.)	Outside Diameter (In.)	Inside Diameter (In.)	Diam. at Weld (In.)	Type Specimen	Test Section Lgth. Before (In.)	Test Section Lgth. After (In.)	Elongation per cent of 6 in.	Total Load Elastic Limit (Lb.)	Total Load Maximum (Lb.)	Unit Strength Elastic Limit (Lb. per sq. in.)	Unit Strength Maximum (Lb. per sq. in.)	Max. on Welded Area (Lb. per sq. in.)
½	0.840	0.622	0.866	Welded	6.00	6.75	12.5	8,540	13,630	33,800	54,000	46,200
"	"	"	"	"	6.00	6.25	4.0	8,790	9,800	34,750	37,600	32,200
"	"	"	"	"	6.00	6.50	8.3	8,700	9,460	34,400	37,400	32,100
"	"	"		Unw'ded	6.00	6.25	4.0	8,130	8,300	32,100	32,800	28,100
"	"	"		"	6.00	7.75	29.0	9,430	14,030	37,300	55,500	
"	"	"		Screwed	6.00	7.75	29.0	9,340	13,980	36,900	55,200	
"	"	"		"	6.00	6.00	0.0		8,730			
¾	1.050	0.795	1.100	Welded	6.00	6.00	0.0		9,650			
"	"	"	"	"	6.00	7.40	23.3	13,680	21,200	37,000	57,500	45,300
"	"	"	"	"	6.00	7.40	23.3	13,110	21,500	35,400	58,200	45,700
"	"	"		Unw'ded	6.00	6.90	15.0	13,700	21,200	37,000	57,500	45,300
"	"	"		"	6.00	6.75	12.5	13,520	21,510	36,800	58,200	45,700
"	"	"		Screwed	6.00	7.50	25.0	12,470	20,250	33,700	54,700	
"	"	"		"	6.00	7.30	21.6	13,060	20,190	35,200	54,400	
1	1.325	1.008	1.360	Welded	6.00	6.00	0.0		14,330			
"	"	"	"	"	6.00	6.00	0.0		13,340			
"	"	"	"	"	6.00	6.60	10.0	18,500	26,780	32,500	46,800	39,900
"	"	"		Unw'ded	6.00	6.70	11.6	18,200	27,600	31,900	48,500	41,200
"	"	"		"	6.00	7.10	18.3	18,260	29,440	32,000	51,700	44,000
"	"	"		Screwed	6.00	7.00	16.6	18,490	29,500	32,400	51,800	44,100
"	"	"		"	6.00	7.70	28.3	18,300	28,300	32,100	49,700	
1½	1.915	1.595	1.945	Welded	6.00	8.10	35.0	18,210	28,060	32,000	49,200	
"	"	"	"	"	6.00	6.00	0.0		17,160			
"	"	"	"	"	6.00	6.00	0.0		17,300			
"	"	"		Unw'ded	6.00	6.50	8.3	28,900	41,990	36,800	52,200	44,200
"	"	"		"	6.00	6.60	10.0	30,000	45,900	38,100	57,400	48,300
"	"	"		Screwed	6.00	6.70	11.6		45,590		57,000	47,900
"	"	"		"	6.00	6.50	8.3	29,490	42,420	36,900	52,900	44,600
					6.00	7.75	29.6		42,910		53,600	
					6.00	7.50	29.2		42,380		52,000	
					6.00	6.00	0.0		31,620			
					6.00	6.00	0.0		30,920			

on either side of the weld, split along the seam in the pipe as far as the butt weld, which held without splitting. One of the screwed fittings sheared the threads and telescoped, and the other bulged outside of the fitting. The characteristics of these failures are shown in Fig. 4.

In most cases the welded tee connections broke in the outlet and at some distance from the weld. All of the screwed tee fittings broke in the casting. The characteristics of these breaks are shown in Fig. 5.

Tables 1 and 2 give respectively the results of the tension and compression tests of the specimens of butt welded pipe, unwelded pipe, and malleable iron screwed pipe couplings.

because of the reduced cross sectional area at the threads, and so has no elastic limit.

The elongation of the 6 inch test sections was less for the welded than the unwelded pipe. But this was even better than the screwed couplings which broke with no elongation.

Table 3 gives the results of the tees tested in tension.

DATA SHEET FOR COMPRESSION TESTS
Standard Weight Steel Pipes
Butt Welded, Unwelded Pipe, and Screwed Couplings
Length of Specimens 5 Inches

Pipe Size (In.)	Outside Diameter (In.)	Inside Diameter (In.)	Diameter at Weld (In.)	Type Specimen	Total Load		Unit Strength		
					Elastic Limit (Lb.)	Maximum (Lb.)	Elastic Limit (Lb./sq. in.)	Maximum (Lb./sq. in.)	Maximum on Welded Area (Lb./sq. in.)
2	2.380	2.138	2.420	Welded	39,500	60,370	45,000	68,600	64,200
"	"	"	"	"	38,860	59,100	44,200	67,200	62,900
"	"	"	"	"	37,860	66,980	42,800	75,900	71,200
"	"	"	"	"	38,450	68,880	43,700	78,300	73,300
"	"	"		Unwelded	37,770	67,000	42,800	76,200	
"	"	"		"	38,000	67,570	43,200	76,800	
"	"	"		Screwed	37,600	50,730	42,700	57,600	
"	"	"		"	37,000	51,730	42,100	58,700	

Table 4 is a summary of the average maximum loads of the welded and screwed specimens as given in Tables 1, 2 and 3. From these average loads, the relative strength of the welded and screwed connections have been computed. These figures (see last column Table 4) show the strength of the welded connections to be from 113 to 171 per cent of the strength of the malleable iron screwed connections.

The higher strength of the welded connections is at once appreciated when the curves in Figs. 6 and 7 are examined. These curves are taken from the data given in Table 4.

TABLE 5
COST OF PIPE CONNECTIONS

Pipe size.	½"	¾"	1"	1½"	2"	3"	4"
Welded Butt Joints							
Time, min.	3	3½	4	5	6	10	15
Oxygen, cu. ft.	0.28	0.43	0.76	0.95	1.51	2.51	4.76
Acetylene, cu. ft.	0.23	0.41	0.74	0.92	1.47	2.44	4.43
Welding wire, oz.	0.08	0.15	0.20	0.30	0.50	1.60	4.00
Cost:							
Labor @ 30c	$0.0150	$0.0175	$0.0200	$0.0250	$0.0300	$0.0500	$0.0750
Oxygen @ 2c	.0056	.0086	.0152	.0190	.0302	.0502	.0952
Acetylene @ 2c	.0046	.0082	.0148	.0184	.0294	.0488	.0886
Welding wire @ 12c	.0006	.0011	.0015	.0023	.0038	.0120	.0300
Total cost	$0.0258	$0.0354	$0.0515	$0.0647	$0.0934	$0.1610	$0.2888
Screwed Couplings							
Cost of fitting	$0.02	$0.03	$0.04	$0.08	$0.11	$0.27	$0.45
Cost of making up joint	0.02	0.02	0.03	0.03	0.04	0.05	0.07
Total cost	$0.04	$0.05	$0.07	$0.11	$0.15	$0.32	$0.52
Welded Tee Joints							
Time, min.	4½	5	5½	7	9	16	22
Oxygen, cu. ft.	0.41	0.61	1.05	1.34	2.26	4.02	6.98
Acetylene, cu. ft.	0.35	0.59	1.01	1.29	2.20	3.88	6.50
Welding wire, oz.	0.20	0.40	0.60	1.00	1.40	5.40	9.50
Cost:							
Labor @ 30c	$0.0225	$0.0250	$0.0275	$0.0350	$0.0450	$0.0800	$0.1100
Oxygen @ 2c	.0082	.0122	.0210	.0268	.0452	.0804	.1396
Acetylene @ 2c	.0070	.0118	.0202	.0258	.0440	.0776	.1300
Welding wire @ 12c	.0015	.0030	.0045	.0075	.0105	.0405	.0713
Total cost	$0.0392	$0.0520	$0.0732	$0.0951	$0.1447	$0.2785	$0.4509
Screwed Tees							
Cost of fitting	$0.04	$0.05	$0.08	$0.14	$0.18	$0.51	$1.02
Cost of making up joint	0.03	0.03	0.04	0.04	0.05	0.06	0.09
Total cost	$0.07	$0.08	$0.12	$0.18	$0.23	$0.57	$1.11

In both of these tests the elastic limit of the welded specimens was practically the same as the unwelded pipe, showing that the elasticity is not much affected by welding.

The screwed coupling specimen broke without elongating

Those who are concerned with the comparative cost of making pipe connections by the two methods will be interested in Table 5 and the curves in Figs. 8 and 9 which are plotted from the data in this table.

TABLE 3
DATA SHEET FOR TENSION TESTS
Standard Weight Steel Pipes
Welded Tees and Screwed Tees

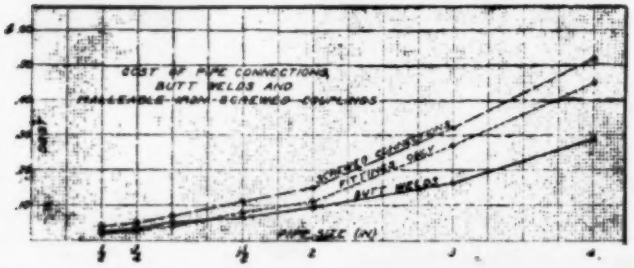
Pipe Size (In.)	Outside Diameter (In.)	Inside Diameter (In.)	Type Specimen	Maximum Load (Lb.)
½	0.840	0.622	Welded	12,250
"	"	"	"	12,210
"	"	"	"	14,250
"	"	"	Screwed	9,300
"	"	"	"	8,145
¾	1.050	0.795	Welded	18,730
"	"	"	"	20,440
"	"	"	"	20,120
"	"	"	Screwed	11,210
"	"	"	"	13,400
1	1.325	1.008	Welded	30,460
"	"	"	"	29,770
"	"	"	"	29,790
"	"	"	Screwed	17,600
"	"	"	"	17,500

The cost of oxygen at the present time varies from 1½ to 2 cents per cubic foot in different parts of the country. The price of 2 cents which has been used in computing these tables is therefore very conservative.

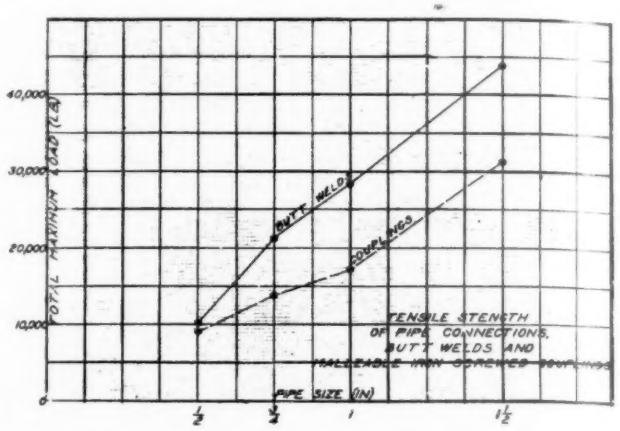
TABLE 4
RELATIVE STRENGTH OF WELDED AND SCREWED PIPE CONNECTIONS

Pipe Size (In.)	Average Maximum Load		Relative Strength Welded Screwed (Per cent)
	Welded Connection (Lb.)	Screwed Connection (Lb.)	
Tension Tests of Butt Welds and Couplings:			
½	10,222	9,040	113
¾	21,367	13,835	154
1	28,330	17,230	164
1½	43,975	31,270	140
Compression Tests of Butt Welds and Couplings:			
2	72,500	58,150	125
Tension Tests of Welded and Screwed Tees			
½	12,903	8,723	148
¾	19,763	12,303	160
1	30,007	17,550	171

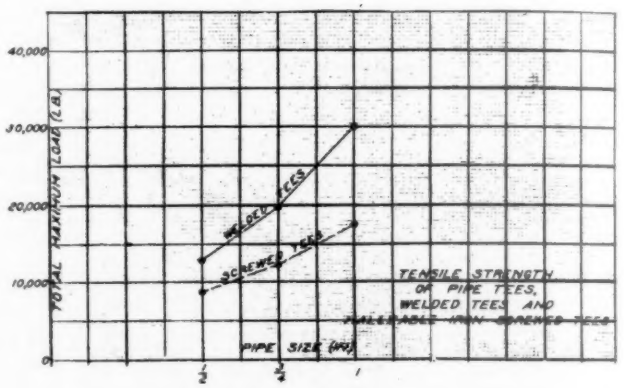
The cost of acetylene at 2 cents per cubic foot is the price if supplied in tanks. If the acetylene were generated as used, the cost would be reduced to a little less than 1 cent per cubic foot.



The curves in Fig. 8 and 9 give the total cost of welded and screwed connections and the cost of the fittings alone. From these curves it is seen that the cost of the fitting is the principal item in the screwed connections. In most cases the cost of the welded joint is less than the cost of the fitting. As the pipe sizes increase, the lower cost of the welded joint is even more marked.

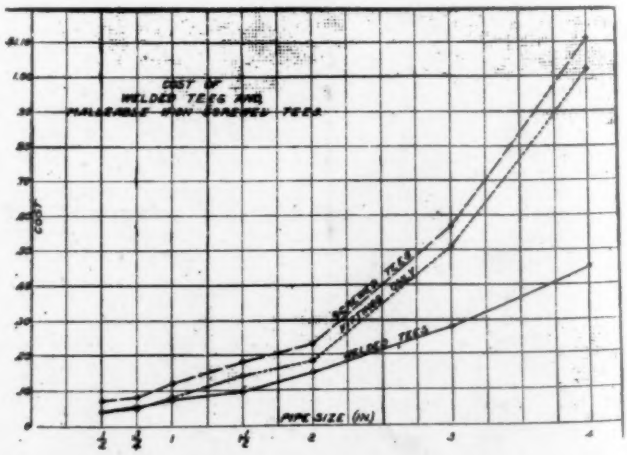


The conclusions that may be drawn of these tests point to the following facts:



a.—The cost of the welded connections is less than the cost of the screwed connections. The larger the pipe size the greater is the difference.

b.—The time required to make up the screwed connections is about the same as that required to make up the welded connections.



c.—The strength of a welded pipe connection is practically the same as that of an unwelded pipe. By building up the weld it can be made as strong or even stronger than the rest of the pipe.

d.—The elasticity of the pipe is not much affected by welding.

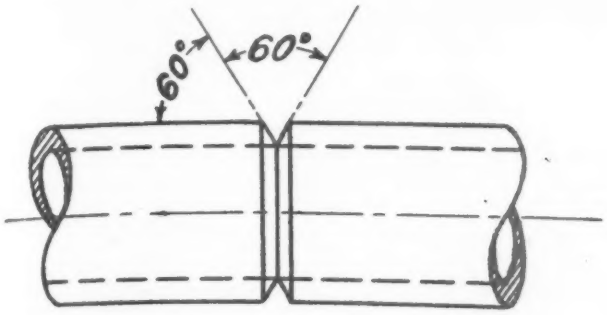


FIG. 1 - PIPE BEVELLED FOR WELDING.

e.—The strength of the welded pipe connections is greater than that of malleable iron screwed fittings. The strength of the welded specimens was from 113 to 171 per cent of that of the screwed connections.

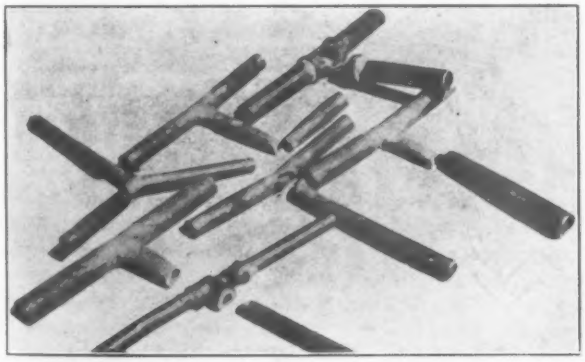
PROBLEMS OF THE JOB SHOP.

The new aluminum pistons and cylinders have appeared in our welding shops. These have been made since 1911 and contrary to all predictions have proved their worth. Incidentally they are the hardest of all aluminum alloys to weld.

In France, Belgium and Italy aluminum cylinders and pistons are old acquaintances of the oxy-acetylene welder, but until this year an occasional Gnome aviation motor of the eight cylinder water cooled type was the only representative of the aluminum cylinder in this country.

In the matter of aluminum pistons, however, the Fiat six cylinder aviation motor and all the racing cars were equipped with aluminum alloy pistons. The Chirribi factory in Italy turned out a few 40-H. P. aviation motors with aluminum cylinders containing cast iron liners.

The Marmon car of 1916 type contains a six cylinder motor with the cylinders and pistons of aluminum. The cylinders are cast en-bloc with a removable cast iron head.



Specimens of Tees Tested in Tension. See Opposite Page.

Very thin sleeves are pressed into the sides of the cylinder along the piston travel.

When welding the cylinders it is not necessary to remove these sleeves unless the crack crosses the piston travel, as the aluminum has a higher co-efficient of expansion then the iron sleeve, the former 0.000023 and the latter 0.0000119. The aluminum when heated will leave the iron ring almost enough to drop out, but if the casting is cooled slowly the aluminum will retain the heat as long as the iron and the two will come back to a perfect fit. Care must be taken with the preheating and the cooling. A manganese bearing rod can be used. Even with less than 1 per cent of manganese, this metal is hard to work and the welder should have a little preliminary practice.

All aluminum alloy pistons and piston rods are made of an alloy containing manganese to harden it. One alloy is called Lynite Aluminum and is made by the Aluminum Castings Co. of Cleveland, Ohio.

All of these can be welded easily. It is said by welders who have experimented on these that a cast rod with plenty of copper in it makes the best welding rod.

Magnalium, is the German imported piston alloy. Magnalite is a sand cast piston alloy and Lynite is the American made alloy, die cast with pressure. Magnalium pistons are used on the Stutz racing cars, which drew many race

Specimens Tested in Tension. See Opposite Page.

prizes last year. Any of these alloys have at least double the strength of pure aluminum and are much easier to machine.

In finishing such castings the welder should never grind on an emery wheel. A lathe job is best and does not fill the aluminum with abrasive particles.

Next year the removable cast iron head of the Marmon car will probably be replaced by an aluminum one. Already

Specimens Tested in Compression. See Opposite Page.

the center case of the rear axle is made of an aluminum alloy.

Another new metal on the market is monel metal, which is being used where freedom from rust and resistance to acids, etc., are desired. It is a compound of nickel and steel, over 85 per cent being of nickel. Its action under the welding flame is almost the same as that of copper. It becomes porous and if heated too hot will burn up entirely. A low heat and quick action in flowing in a rod of the same metal will solve the combination. The metal shows no color under heat, merely evaporating. It has almost the same tensile strength as steel and is welded in electric butt welders in large quantities successfully.

Col. B. W. Dunn, Chief Inspector of the Bureau for the Safe Transportation of Explosives and other dangerous articles, has resigned to engage in the manufacture of munitions. His successor has not yet been selected. Col. Dunn is recognized as being an authority on explosives and their safe handling, and the work he has done for the Bureau has been very valuable to the welding trade.

Conservation of the Eyes of Welders

By WILLIAM C. ADAMS

"Safety First" is the slogan of the industrial world today. The safety of employees is having the attention of the largest and smallest employers in every branch of industry. "Safety First" in its real sense is the anticipation of a cause before it exists. This absolutely necessitates the presence of proper safety appliances for both men and machines.

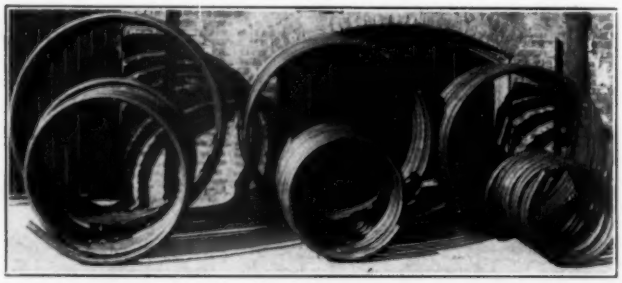
When one considers that today there is an ever increasing army of 80,000 blind and partially blind men in America, who have lost their earning capacity through industrial eye accidents, the proper protection of the eye is self-evident. had been trained in their service for years, if by any exp di-ture of money or care, such injuries could be prevented

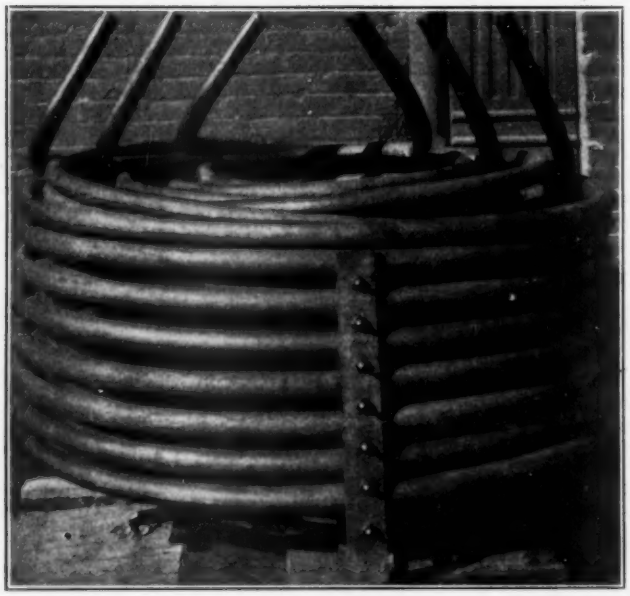
Of all industrial occupations welders require eye ro-tection the most. In addition from flying particles of i an-descent iron and steel they should be protected from wo sources.

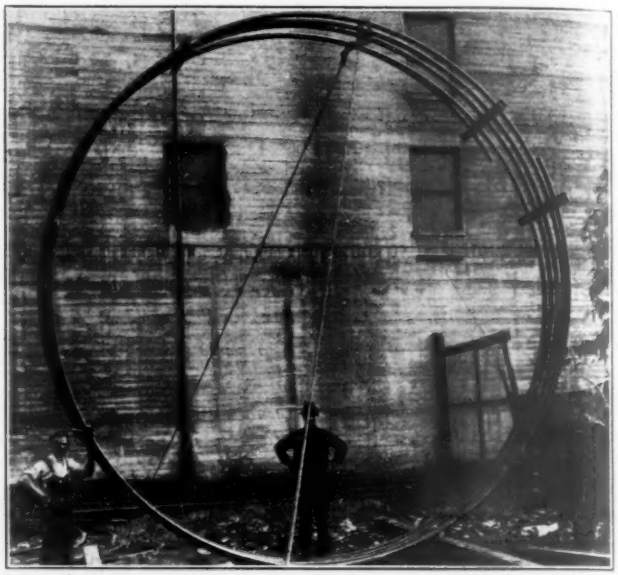
1st. Intensity of Light.

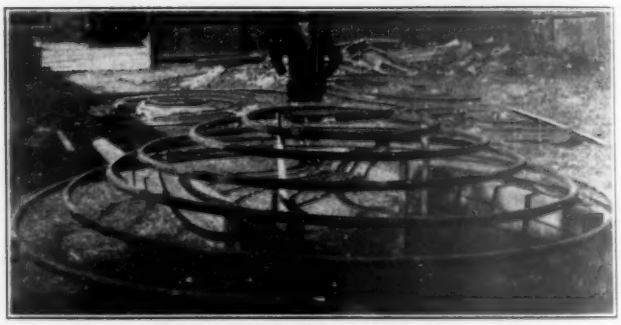
2nd. The chemically active Ultra-Violet and Infer Red rays of the Spectrum.

There is only a certain kind of light that is injurious to









Upper left—Coils of 1½ inh pipe, ranging from 24 inches to 56 inches in diameter. Upper right—Coil contains 300 feet of 2 inch pipe and is 19 feet in diameter. Lower left—The coil is made up of series of coils shown in upper right. Lower right—Spiral conical coil contains 200 feet 2-inch pipe. This work was done by the H. R. Boynton Company, Los Angeles. **See page 21 for details of work.**

These injuries in ceratin lines of manufacturing often run to 35 and 40 per cent of the total number of casualties.

Eye protection in the industries involves the vital elements of the relation existing between employer and employee and its chief problem is to demonstrate to them that what is of permanent advantage to one is permanent good to the other, and to establish as fundamental in this relation the principle that until danger in every form is eliminated both will suffer.

Although recent and active legislation and a great interest shown by Insurance Companies have added emphasis to the "Safety First" movement, it is extremely doubtful if all the legislation enacted to date has accomplished as great a reduction in the percentage of accidents in industrial life as the sudden (although too long delayed) realization of those at the head of industrial corporations and manufacturing concerns that their responsibility extended much further in this direction than they had believed, and that it was poor business to permit the injury or death of workers who perhaps

the eyes. This part of the light is evidently that which can exert a chemical effect. In dividing light into its primary colors represented by the spectrum it has been known for some time that the rays at the upper end of the spectrum, namely, the ultra-violet, and the rays at the lower end known as the infer red rays, are chemically active and consequently harmful to the eyes. The problem then was to find a glass of such a shade that these rays would be completely absorbed.

At the same time the quality of the glass should be such that the quantity of light transmitted must not be affected except as desired, this quantity being controlled by the depth of color.

There are a great many colors and shades of glass that eliminate more or less of the injurious rays and it is impossible to be sure that one is better than the other. Manufacturers of special glass claim that their glass cuts out more of the harmful rays of light than any other, but one thing is cer-

tain, the darker or deep shades cut out the most, and it is well to use as dark a shade as is convenient; the density should be regulated by the class of work, lighter shades for light work and darker shades for heavy work.

Colors Commonly Used for Welding

There are a variety of colors used by welders, blue, smoked or gray, amber, Fieuzel (yellowish green), Hallauer (gray green), Euphos (greenish yellow), Akopas (yellowish green), Noviweld (gray amber).

Blue glass shuts out the heat rays but not the ultra violet. Amber in darker shades cuts out the ultra-violet rays. Smoked glass is good to use but it shuts out more illumination than some of the other shades; Fieuzel or Chlorophylle was invented in 1880 by D'. Fieuzel of Paris. A great deal is claimed for this glass. Hallauer glass was invented in 1906 by Dr. Otto Hallauer of Basil, Switzerland, and is said by some to be superior to the Fieuzel. They claim it absorbs more of the chemically active rays than any other glass. Euphos, invented in 1907 by Drs. Schanz and Stockhausen of Dresden, formerly made in six shades but at present only in two shades, was adopted by the German Government. Akopas is another recently invented glass. Noviweld is an American product made by the Corning Glass Works at Corning, N. Y. It is the first optical glass manufactured in this country and is really a fine glass.

All the different colors and kinds of glass herein mentioned are suitable to use, but it is important to use a glass that is free from refractive elements, that is, the surfaces either in flat, Mi-Coquille or regular Coquille should have parallel surfaces or the same curve on both sides and as free as possible from waves and imperfections. It is not absolutely necessary to have the highest priced glass for safety and comfort.

A first quality Mi-Coquille glass is not injurious and is perfectly comfortable to wear. There are all kinds of opinions among welders as to what color is the best. They are largely influenced by the shade they are used to. The great majority prefer smoky green. It is necessary to wear the same shade all the time for the same class of work.

Now that the welding industry has grown to such an extent and the absolute necessity for the welder to use goggles there will probably be a great many new types and colors put on the market, the manufacturers of each claiming that they have the only glass that cuts out all the ultra-violet rays and all the heat rays and that their glass is the only kind to use.

The important thing for the welder to have in mind is, be sure and wear some protection. Be sure to have the glass dark enough to prevent the eyes from smarting and getting inflamed after a day's work. The better quality glass used the less density is required.

WELDING PIPE

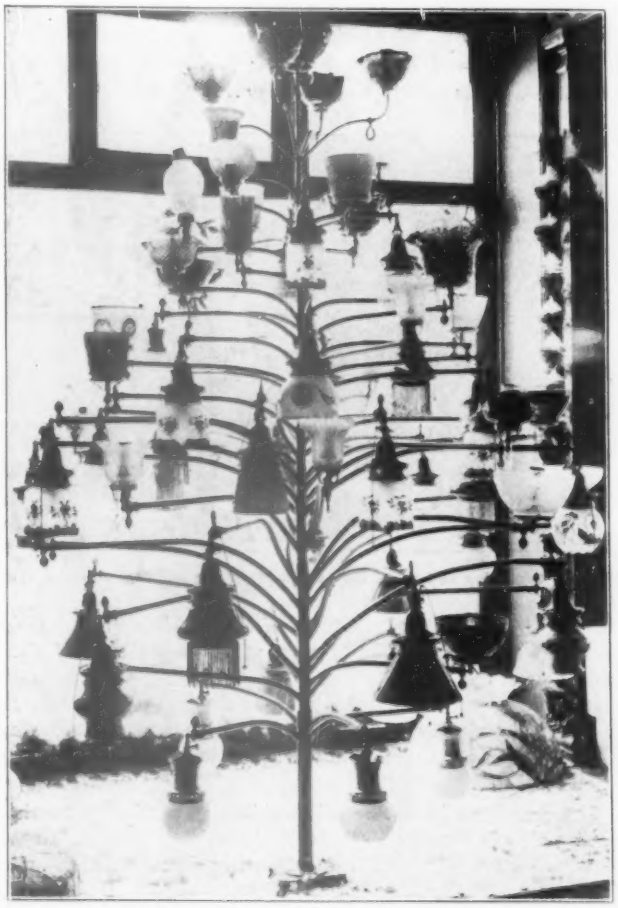
What we believe to be rather remarkable pipe coiling work with the aid of oxy-acetylene welding is being done by the H. R. Boynton Company, Los Angeles. The pipe is welded in straight lengths and is then bent cold in a patent bending machine designed by the company. This, of course, subjects the welding to an unusual strain, as the weld must stand the same amount of bending as the pipe. The completed coils are subjected to a test of 200 lbs.' pressure after being completed, and it is said that the percentage of leaks found is so small as to be hardly worthy of consideration.

This work demonstrates very forcibly the strength of oxy-acetylene welding, and it also reflects credit on the bending apparatus of the Boynton Company.

WELDED GAS PIPE CHRISTMAS TREE

General Manager Shattuck and his superintendents, Mr. Wilde and Mr. Fox, claim the distinction of first welding high-pressure gas mains in this country, a method now generally employed, doing away with the former threaded joints and couplings. This was early in 1911, when 1,000 feet of 4-in. high-pressure main was welded in a Philadelphia suburb, the welding being done by the Davis-Bournonville Company, manufacturers of oxy-acetylene apparatus, under supervision of W. W. Barnes, that company's Philadelphia mananger. Since then the Philadelphia Gas Company has employed the welding process extensively both in its gas mains and in repair departments.

The trunk of the Christmas tree is of six sizes of pipe, welded together, reducing from 1¼-in. to 1-in., ¾, ½, ⅜ and ¼-in. at the top. There are 73 branches welded to the



Christmas Tree Made of Welded Pipe.

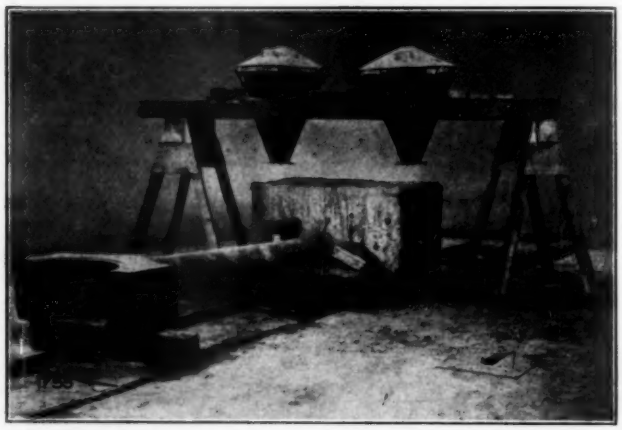
trunk, the lower branches ⅜-in. pipe, the middle ones of ¼-in. and the top branches of ⅛-in. pipe. For each of these branches the hole was cut into the trunk with the oxy-acetylene cutting torch. After being welded, the branches were heated with the welding torch and bent into the shape desired, and the whole was found gas-tight when each limb was fitted with a Welsbach burner and with assorted colored glass shades, showing the great variety sold by the company's commercial department.

At the forthcoming show to be held by the railway supply people at the Coliseum several concerns interested in the welding trade will exhibit. While a great deal of welding is being done on American railroads there is much room for expansion. In the signal departments, for instance, we have never heard that much welding is being done. On the other hand there are hundreds of thousands of feet of thread connected pipe in service at interlocking plants, which gives some trouble. Welded pipe would be better, cost less and require less maintenance.

WELDING CONNECTING ROD WITH THERMIT.

The accompanying illustrations show a repair recently completed by the Thermit Process at the Lorain Works of the National Tube Company, Lorain, Ohio. This repair consisted in welding a broken connecting rod for a 50x60-inch Galaway mill engine. The section at the break was 10x12 inches and the weld was completed with the use of 700 lbs. of Thermit.

As there are doubtless many readers of The Welding Engineer who are not familiar with the Thermit Process they may be interested in knowing that Thermit is a mixture of finely divided aluminum and iron oxide. This mixture can be ignited by means of a special ignition powder and then a chemical reaction takes place between the aluminum and the iron oxide. The aluminum burns to form a aluminum oxide, taking its oxygen from the iron oxide. This leaves the iron free and it settles to the bottom of the crucible or containing vessel in the form of liquid steel at a temperature of about 5,000 degrees F.



Thermit Crucibles and Mold Box in Position for Making Thermit Weld.

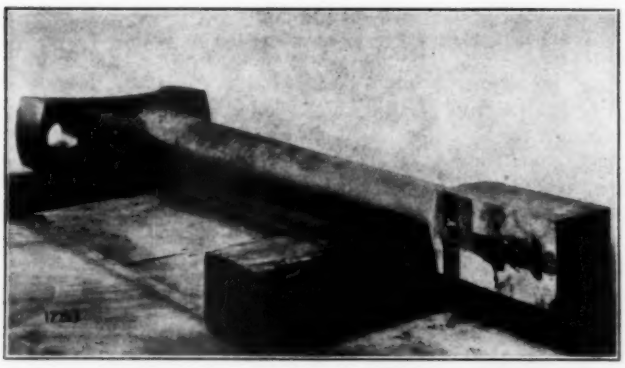
In making repairs by the process the parts to be welded together are simply melted down by this superheated steel, which fuses with them to form a single homogeneous mass when cool.

The first step in a Thermit welding operation is to thoroughly clean the parts to be welded and then provide a space between them of from 1 to 2 inches in width to enable the concentration of a mass of Thermit steel between them and thus melt them down. Usually this space has to be cut out and for this purpose the oxygen cutting flame is generally used. A sand mold is then built up around the parts providing for a collar or reinforcement all around the sections to be welded. This enables the concentration of additional Thermit steel around the outside of the sections, which also assists in the melting process and insures a thorough amalgamation of metal. In practice, a pattern of yellow wax is formed on the outside of the sections in the shape desired and the sand mold rammed against the wax, using wooden patterns for pouring gate, a small opening at the bottom for preheating and a large riser over the top. The flame of a gasoline compressed air torch is then directed into the preheating opening, melting out the wax and leaving the mold ready for pouring. The heat is continued until the parts are red hot and at which time the preheater opening is closed and the Thermit charge ignited.

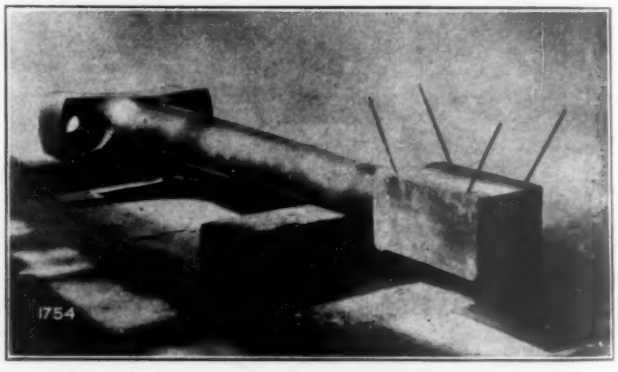
The Thermit reaction takes place in a magnesia tar lined crucible and at the end of the reaction the steel is tapped into the mold where it flows around and between the parts to be welded together and then into the riser. The mold is allowed to cool for at least 12 hours in the case of fairly small welds and sometimes several days in the case of very large welds so as to enable the metal in the weld to cool slowly and become thoroughly annealed. The mold can then be broken up, the metal left in pouring gates and risers removed and also any surplus metal which may interfere with the operation of the repaired parts.

Thermit Weld With Pouring Gates and Risers.

As a general rule the Thermit Process is best adapted to fairly heavy welding operations and its greatest field of application has been in railroad shops, where it is used for welding broken locomotive frames, driving wheel spokes, cross heads and similar sections. In steel mills the process is largely used for welding broken connecting rods, rolls, ladle frames and for welding teeth in large pinions to replace teeth broken out. At the present time there is a very great demand for the process in steel mills as most of these mills are working under high pressure and the breakage of important machine parts is frequent and often involves heavy loss unless the parts can be quickly repaired.



Fractured Rod Prepared for Thermit Welding.



Wax Pattern Applied and Vent Rods.

ELECTRIC ARC WELDING*

By R. H. Parsons

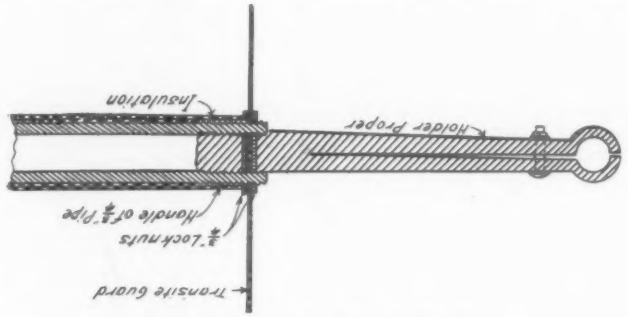
Electric arc welding is no longer an experiment, it is an established economy. Each day a new adaptation is found for its use, and each month finds the scrap pile smaller than the last.

It has been described, illustrated and used to that extent that very few are not familiar with its advantages, but notwithstanding the simplicity, reliability and convenience of an electric arc welding set, its use is not as general as one would expect.

The writer has had considerable experience with elecric arc welding, and trusts that his experience may benefit other readers of this publication.

About four years ago an electric welding outfit was made up under my direction, as an experiment, to find if the process was reliable and practical for street railway work, and if its work stood up.

My first experience with electric welding was with a water barrel rheostat to reduce 500-volt main line current to about 50 volts which should be used for welding. This outfit proved in a short time that the electric arc welding process was entirely successful, but that the method was not, although it does fairly well for an initial trial, or for a temporary outfit where no generator set nor grid resistance



Sketch of Electric Welding Handle.

is available. If a hogshead or fairly large tank is at hand, or if a smaller barrel and running water are convenient, a good serviceable electric arc welding outfit can be constructed easily and quickly.

The barrel or tank should be well set up and insulated from the ground, as it is thoroughly alive, as will be found if anyone is curious enough to place his hand in the barrel for the purpose of determining whether or not the water is hot.

The rough sketch will briefly show a tank, placed on supports with the proper fixtures. For convenience the wire which leads to the water rheostat is fitted with a hook and taped to a light stick long enough to reach the trolley wire, if that should chance to be the source of power; permanent connections through a switch and circuit breaker, however, are very much better.

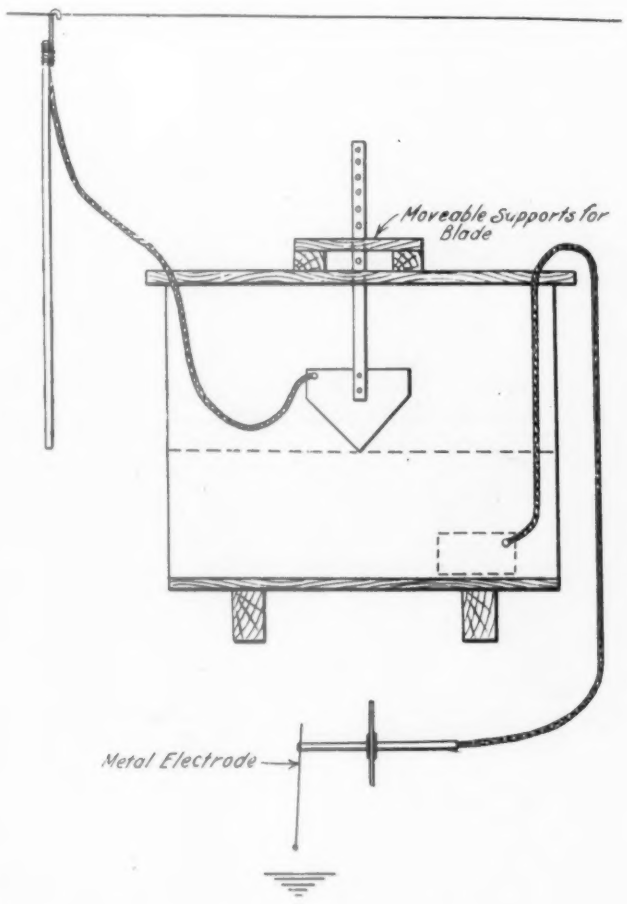
The iron blade to which this wire is connected controls the current output of the rheostat, and is hung on supports simply set across the top of the barrel.

This manner of suspension, together with the holes in the piece of wood to which the blade is attached, gives a wide variation in current, as the whole can be moved from one side to the other, getting as much or as little distance between the blades as desired. The principal trouble with the water barrel for welding is that it has not capacity enough. The water gets too hot and boils over and fresh water must be added, then more salt thrown in. If care is taken, however, not to allow the current on so long at a time that the water boils, good work can be obtained from this simple outfit.

Published in Electric Traction for February.

The welding handle is simple, but must be carefully made and insulated, as it carries the full voltage, and it must also be light, as the discomforts of electric arc welding are sufficient so that they should not be aggravated with a heavy handle to carry.

A piece of ¾-in. pipe, 12 in. long, is threaded inside and outside on one end and left plain on the other end. The outside thread is standard ¾-in. pipe size, and the inside is tapped to fit a ½-in. pipe thread. A piece of steel is fitted and threaded to fit into this ½-in. thread on the inside of the ¾-in. pipe. This piece of steel is 12 in. long



Sketch of Water Rheostat for Welding.

and is split on the outer end and shaped to fit a ⅞-in. round welding pencil, the split part fitted with a bolt to give a clamping effect to hold the pencil tight.

A piece of ¼-in. transite is cut to the shape of a 12-in. circle with a hole in the center which will make a tight fit over the threaded portion of the ¾-in. pipe, and is held there by means of lock nuts on each side. This acts as a shield from the heat. The wire, which should be very flexible, is soldered into the plain end of the pipe, and the handle from the wire to the shield is well covered with rubber and friction tape, which is then painted with a good insulating varnish.

The steel holder proper, after a time, will burn, making a change needed, and to do so it is only necessary to unscrew it from the pipe handle and replace it.

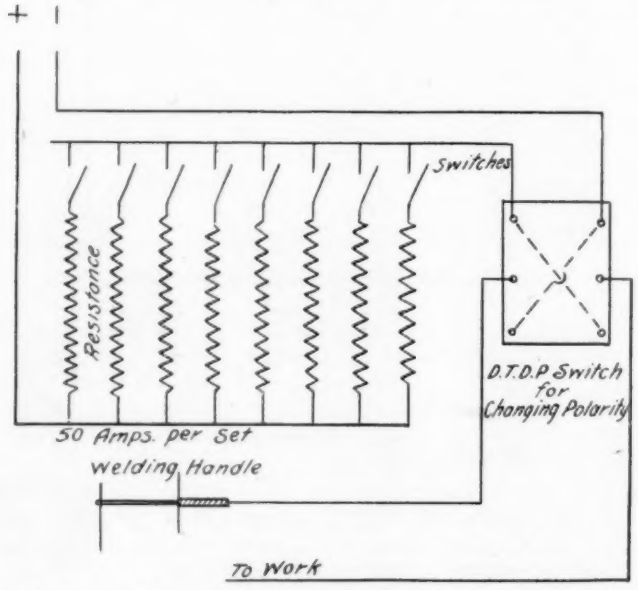
Now comes the question as to whether a carbon pencil or a metal electrode is to be used, and this is determined by the class of work and other conditions. I will explain the two methods and will touch upon the adaptation of each later.

When the carbon pencil is used, a much greater current

can be controlled and it will be found much more practical than the metal electrode for the majority of work.

The carbon pencil method is that where the current is conducted from the work, through a piece of carbon, to the handle, and the metal which is being added, or fused into the work, is held in the left hand of the operator and is placed in the arc long enough to fuse, the molten metal falling into the part being welded and joined to the metal, which is a part of the work, by the aid of the arc. Using this method, the work must be connected to the positive lead and the handle to the negative, and for this reason it is not as safe a procedure as the metal electrode way, when current is taken from the trolley wire, as the work or work table would have to be connected directly to the trolley and would, therefore, be dangerous. The current used with this method can be varied from 125 to 500 amp., or possibly more.

The metal electrode attached direct to the operator's handle in place of the carbon is the other method. Using this, the current passes from the trolley through the electrode to the work, and as the arc is formed small particles of metal are fused and run directly into the weld. In this instance the positive lead is connected to the handle and the work is connected to the negative or ground lead. For



Sketch Showing Connections for Grid Rheostats Used for Welding With Line Voltage.

this reason the latter method is better for use on track work and other places where it is difficult to insulate the work from ground.

The next better type of welding outfit is one constructed of cast grids, arranged with switches, etc., so that the current may be varied to suit the nature of the work.

The best way to build the above is to see what grids are available. Perhaps there is on hand a number of grids which are obsolete and which could be used advantageously in this manner. Determine what the carrying capacity of these grids is, and how many of them must be placed in series to obtain with the voltage at hand the current which will not damage the grid. For instance, if the grids you wish to use will carry 50 amp. and you have a voltage of 550, place enough of these in series so that the addded resistance of all the grids will hold the current to 50 amp. if placed directly across the line. This will give you one set from which you may draw 50 amp. continually, without heating the grids. If you wish to use 100 amp. you can then place two of these sets in multiple, and so on until you have what you wish.

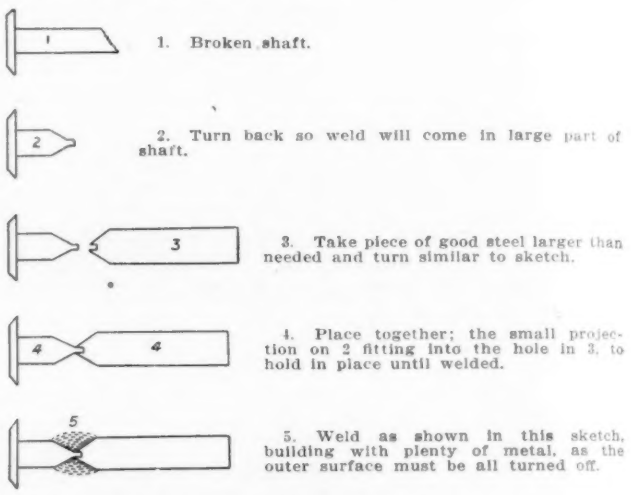
The accompanying sketch illustrates the manner of connection for these grids, also shows switches for cutting in or out sets as needed and for changing the polarity of the leads.

Both of the above-mentioned outfits, while cheap to install, are not as efficient as a motor-generator set which will give the proper kw. output, rather than taking line current and wasting a large per cent through resistance, and although the saving in a generator set over plain resistance is not as great as that which it would seem when figured according to rules, which fact is proven by the use of a wattmeter, the difference will well warrant the purchase of a generator set.

At the same time the economies effected by the use of the arc welding set, constructed of grid resistance and using line voltage, are so decided that the current which is wasted is many times over offset by the value in real money rescued from the scrap pile.

Generally it will be found that with the grid resistance the power consumption in money used by a welder working all day will equal about one-third of his wages.

The uses to which a welding outfit can be adapted are so numerous that space will only warrant a few of the principal ones and how they are done.



1. Broken shaft.

2. Turn back so weld will come in large part of shaft.

3. Take piece of good steel larger than needed and turn similar to sketch.

4. Place together; the small projection on 2 fitting into the hole in 3, to hold in place until welded.

5. Weld as shown in this sketch, building with plenty of metal, as the outer surface must be all turned off.

6. Get new center and turn to correct size.

7. The pencil method has been found most satisfactory for this work. Use from 300 to 350 amp. and cold rolled steel as a filling metal. It should be hammered well as it is being built up.

Sketches Showing Method of Welding Armature Shafts

Three hundred or more Westinghouse 56 motors had the axle lug broken off or cracked on the pinion end. About 30 were repaired by the Thermit process at a cost of about $25 each. The balance were done by the pencil method, using about 350 amp., and although the work was done three years ago, that they are all still in service and in good condition proves the value of the work. The cost was $3.50 each.

To weld a patch on a malleable iron gear case is a simple matter. All that is necessary is to thoroughly burn off the grease and dirt, cut a patch of ordinary ¼-in. flat iron which will cover the iron, and with the pencil only, using no additional metal, fuse the metal of the gear case together with the edges of the patch, making a neat solid job, and one which although it may not be a perfect union of metals, as it is difficult to weld malleable iron, gives a perfectly grease tight union which will not come off.

Armature shafts have been welded in large numbers and they do not again break. The method of doing this is to follow the accompanying sketches.

For filling dowel holes, again the pencil method is best, as it leaves the work soft enough to be drilled and the material used for filling can be an ordinary grade of commercial steel. Often a beginner filling dowel holes in a large casting will find that on account of the large area of the casting the newly formed metal will cool so quickly that

it will be very hard and difficult to drill. Keeping the arc on so long that a quantity of the metal of the casting itself melts and flows down into the hole will often make a hard spot. One thing which will assist in keeping the new metal workable is to cover it over with lime as soon as it is finished, thus keeping the air from the metal. The success of this job particularly depends on the practice of the operator and not on instructions. He must find out most of these points for himself.

For building up worn keyways, etc., the metal electrode can be used, but I still favor the pencil method for this.

For repairing air reservoirs, or for filling holes in castings which do not have to be machined the metal electrode will be found better.

Cast iron can be successfully welded with the electric arc, but it requires care and patience, and should in all except light work be preheated.

The best way is to place the work in a forge and build a good charcoal fire all around the casting, making sure all parts are being heated equally. While in the fire, after the casting is well heated, it should be welded, and when finished should be left in the fire and allowed to cool slowly as the fire dies down and goes out.

This, and this only, will prevent cracking of the casting.

Truck frames, if broken, can easily be welded or can be filled around the pedestals if they are worn.

Round carbon pencils, 7/8x6 in., were first used, at a cost of about .04 cents each, but on test it was found that a special grade graphite pencil at a cost of 6 cents gave about three times the service that was obtained from the carbon. It was also found that while using carbon pencils a certain amount of the carbon got into the weld, making it hard, while the use of graphite pencils overcame this.

Originally it was thought necessary to use pure Norway iron, as free from carbon as possible, to get a weld which could be machined, but here again practice won out and now it is found that just as good results are obtained if the metal used for welding is practically the same as the part being welded.

There are many places where the electric arc can be used advantageously for burning, but it does not shine particularly for this purpose. For burning off corners of flat iron, rivet or bolt heads or other places where it is not necessary to save the part burned off, it is good, as it works quickly and surely, a current of 400 amp. or more being necessary. It, however, heats up the surrounding parts much more than any other process, and it is not especially recommended for work other than building up and welding.

WOODS ELECTRIC MOTOR VEHICLE COMPANY PERFORMS INTERESTING WORK

The makers of the Woods Electric, one of the most beautifully finished of all the automobiles made in America, have developed the welding of parts until welding has become one of the most essential processes used in the manufacture of Woods cars.

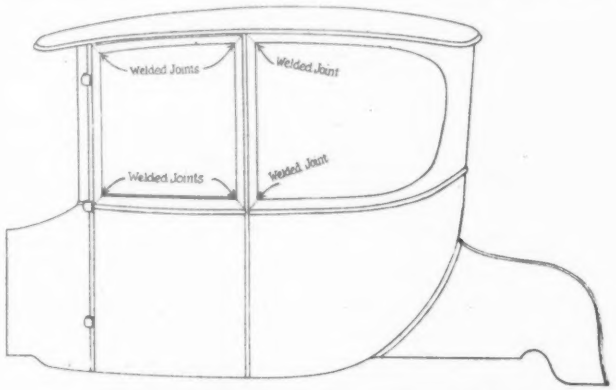
A new installation for the use of ordinary city illuminating gas in connection with tanked oxygen has been installed by Mr. E. Raven Rosen-Baum, a well-known consulting engineer on high temperature gases, of New York City. This is worthy of notice on account of its simplicity of operation, as well as of its efficiency and economy.

Ordinary lighting or fuel gas is washed through a bath of glycerine to remove any inert substance, which causes the corporations furnishing the gas a great deal of trouble occasionally by collecting in the bends of the pipes, and often has to be cleaned out to clear the line of pipe.

As yet in the Woods works the process is used only for lead burning in place of hydrogen and air. In the making of battery connections solid bars of lead are welded together to make the connections. This is known as lead burning.

After being raised to a pressure of two pounds to the square inch, illuminating gas is piped around the shop, meeting the oxygen line on the workman's bench. The oxygen is supplied to a second pipe line from an ordinary pressure oxygen tank at the original pressure of 1,800 lbs. per square inch, and is reduced through a stationary regulator of Standard type to a pressure of 35 lbs. per square inch.

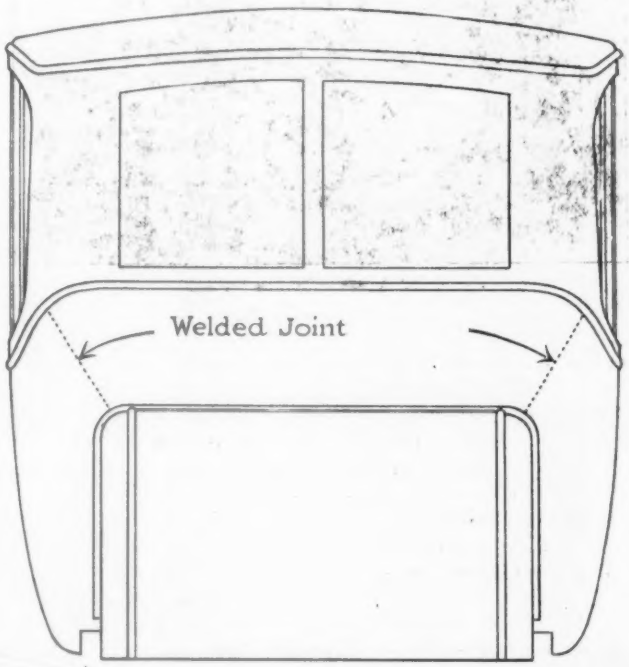
The mixing chamber individually erected for each torch on the workman's bench is built on an injector principle arranged with lubricating check valve of special design on the oxygen to prevent the flow of the oxygen to go back in the illuminating gas line. From the mixing chamber a



How Woods Company Weld Aluminum Bodies.

single tube leads to the torch or the lead burner that is being used.

It is the intention of the Woods Company as expressed through its engineering department to introduce this method into the aluminum and cast iron welding departments, as the heat is sufficient for any metals except steel, and experimental trials have proven a marked saving and increased efficiency.



Woods Electric—Showing Welded Joints.

For instance, the oxygen consumption for a Standard lead burning torch, such as is used for hydrogen and air, is sixty hours to the hundred feet of oxygen, with an almost unmeasurably small expenditure of illuminating gas. Other advantages are its bright, clean and distinct neutral flame superior to hydrogen and air apparatus, and absolute safety of the process.

This firm has used welding continuously for seven years. Their welded products consist of the intricate aluminum

body, which is made of many sheets of 22-gauge soft drawn aluminum.

An excellent and high-priced flux is used and the torch is so held that the distinct neutral cone never touches the sheet, but only plays on the welding rod, which is withdrawn along the line of the weld as the torch is advanced by the operator.

A lesson which can be consummated from this method of aluminum sheet welding is that it is unnecessary in many cases to fuse the two edges of the crack together before adding the filling material of the welding stick to obtain a perfect butt weld. The molten material dropped off the end of the rod has sufficient heat to perform a perfect fusion, and in order to obtain perfect autogenous welding rods, narrow sections of the sheet stock, the same as used in the bodies, are employed.

In addition to this interesting aluminum body work, the chassis frame is welded at the points where cross members connect with the side bars. Here is steel employed which is called an open hearth, low carbon drawing steel, containing from 10 to 20 points of carbon.

WELDED PRESSURE GAS TANKS

These tanks are built for the storage of oxygen or hydrogen under pressure, and welded by Davis-Bournonville Company at the Jersey City shops. They are 9 feet 6 inches long, 2 feet 7 inches diameter, the cylinder of ½-inch steel, the heads and bottoms of $\frac{7}{16}$-inch steel, the edges of the plate beveled to 45° for welding, and have a capacity of 1,000 cubic feet of free gas compressed at 300 pounds pressure.

Welded Pressure Gas Tanks.

After being welded they are tested to 800 pounds hydraulic pressure.

There was 76 lineal feet of welding on the three tanks shown, and the actual time of welding, gas consumption, and material employed is shown by the following figures:

Welding three longitudinal seams	6 hours
Helper's time	6 hours
Welding six heads	12 hours
Acetylene consumed	896 cubic feet
Oxygen consumed	1056 cubic feet
Titan welding rods	37½ pounds

The Davis-Bournonville Style C welding torch, with No. 9 tip, with oxygen under 18 pounds and acetylene under 6 pounds pressure, was used.

A NEW BOOK

Frederick J. Drake & Co., publishers, Chicago, Ill., have just issued a new book of 216 pages, with illustrations. The author is Harold P. Manly, chief engineer of the American Bureau of Engineering. The price of the book in cloth binding is $1.00, leather $1.50, and it can be secured from The Welding Engineer.

Michigan has just passed a law compelling the painting of all gasoline cans a bright red.

AIR BRAKE PIPING AND ACETYLENE WELDING

The anatomic parts of the air brake, consisting of the air pump that produces the pressure, the pump governor that controls the pressure, the main reservoirs in which the pressure is stored, the driver brake valve which controls the admission to and exhaust of air from the brake pipe to release and apply the brakes, have all gone through many changes since their discovery in 1874 till now when the automatic air brake, the automatic quick action brake, the high speed brake, the independent straight air brake and the train air and signal have reached a high efficiency; the brake pipes however, that are the bowels of this organ have not met with the same fate; they are still used in their crude form as when they were first applied.

It is a well known fact among railroad men of the many failures experienced on the road in pipes, leaking or breaking, due chiefly to threaded joints; this defect was recognized by a leading Master Mechanic of an important road and immediately set to find a remedy; on my suggestion, he shopped a heavy type passenger locomotive and gave it over to me for improving the brake pipes.

My purpose was to eliminate as many fittings as possible and it was here that I brought in the use of the acetylene process replacing welds for joints; the result was that the same locomotive ran for six months without having any pipe failures and at the same time reducing the cost of maintenance to 50 per cent.

There are many railroad shops that have the oxy-acetylene apparatus; have invested time and money; yet have defrauded themselves daily of the benefit, due to doubt and mistrust of the process. Here is one of the many uses where the process can be used advantageously and in which little skill is necessary.

The air brake piping of the locomotive the least developed member of the air brake, can thus be pitched to the same high efficiency as the other members, reducing nipples, tees, elbows and sleeves to a few welded pipes coupled with a limited amount of unions or flanges.

B. K.

DAVIS-BOURNONVILLE COMPANY CHANGES

The Davis-Bournonville Company, New York and Chicago, manufacturers of oxy-acetylene and oxy-hydrogen welding and cutting apparatus, has announced several changes and additions in its selling organization. W. R. Noxon succeeds W. S. Schoenthaler as manager of the Chicago office, Mr. Schoenthaler going to the company's general offices in Jersey City. Mr. Noxon's association with the company began in 1908, soon after the oxy-acetylene process was introduced in this country. H. H. Armstrong was recently appointed district sales manager for the Pittsburgh district, the Pittsburgh sales office and demonstrating plant being removed to 316 Penn Avenue. A demonstrating plant and commercial welding department has been established at 147 West Austin Avenue, Chicago, with F. J. Maeurer, formerly superintendent of the welding department at the Jersey City shops, in charge, H. Ulmer succeeding him as superintendent of the Jersey City welding department. John B. Redd, formerly with the Pacific Gas & Electric Company, and superintendent of the Collective Gas Exhibit at the Panama-Pacific Exposition, and George S. Pearson, recently with the American Stove Company and superintendent of that company's exhibit at the Panma-Pacific Exposition, have joined the Davis-Bournonville sales organization. Mr. Redd will give special attention to the artificial and natural gas industry in application of oxy-acetylene welding to pipe lines and other work, and Mr. Pearson will be connected with the general offices at Jersey City. The company is now erecting an additional building at the Jersey City plant, which will give 40,000 additional feet of floor space, providing for approximately double its present production of apparatus.

Aceteylene

Its Production, Compression, Shipment and Use in Oxy-Acetylene Welding and Cutting

A chain is as strong as its weakest link, so, in building up an industry its success is dependent, not upon any particular feature or circumstance, but upon all the factors entering into the conduct of the business.

In as complicated an organization as one engaged in the production and vending of a highly explosive and inflammable commodity, there are countless factors which make for success or failure.

That this has been recognized by the producer, is shown by the many well-thought-out features of safety, with which he has sought to protect his industry and its patrons.

By genuine co-operation between the various producers of acetylene gas, and Col. B. W. Dunn, chief inspector of the American Railway Association's Bureau for the Transportation of Explosives and other Dangerous Articles, (by freight or express), a very comprehensive set of rules and regulations has been evolved. These cover exhaustively the method of shipping acetylene and also prescribe the type of container to be used.

These regulations became law by their adoption by the Interstate Commerce Commission, so that now we have one set of rules by which the industry is governed throughout the United States.

There remains at the present time but one weak link, and unfortunately this can only be strengthened by the co-operation of the consumer. We all want efficient service, but what have we done to secure it? The producer and the government have done all in their power to perfect and safeguard the product. At the present time every manufacturer and shipper of compressed acetylene, is groaning under the ever increasing burden of excess cylinders.

True, the industry has grown by leaps and bounds to an extent hardly realized, yet the demand for cylinders is entirely disproportionate. Thousands of dollars are tied up in cylinder equipment, in an endeavor, on the part of the manufacturer, to meet the ever increasing demand but, with the present condition of the metal market, there is a limit, which is well nigh reached, to what he can do.

The only solution lies in a closer co-operation between the acetylene manufacturer and the acetylene user.

Mr. Welder, you expect above all things prompt service. Help in obtaining it. And you can help by the prompt return of empty cylinders. If you can return it in the morning—do it—don't wait till the next morning. A cylinder can be recharged at best about twelve times in a year, and nowhere near as often if you hold out the empties. Boost for yourself, and the efficiency of the oxy-acetylene process by helping the fellow whom you insist shall help you.

This industry affords a livelihood to many thousands of men. Consider yourself part of it—one of its many links, and don't be the weak link.

The following article is written and submitted by The Welding Engineer, so that you may know as much as the next fellow about the material you handle without wading through a mass of technical literature. You will avoid the other fellow's mistakes and accidents, and so be able to handle your materials more satisfactorily.

Attractive Display of the Davis-Bournonville Company at the Panama-Pacific Medal Winners' Exposition, Chicago Collseum, March 1st to 12th.

Acetylene

Acetylene is a gas composed of 93 per cent carbon and 7 per cent hydrogen and is produced by the action of water on calcium carbide, which latter is produced by the fusion of lime and coke. In a dry state calcium carbide presents no risks and will pass through any fire being non-inflammable. If acted upon by water it immediately decomposes, giving off acetylene gas, the residue being slacked lime.

Generation

This property led to the construction of the acetylene generator. There were originally two types, known as the water to carbide, and the carbide to water type. The former, in which water was allowed to touch or flow on the carbide, is

now almost obsolete. It presented many bad features and hazards. The evolution of extreme heat, thus producing poor gas, and frequently sufficient heat to cause explosion. The other type is in common use in the field of acetylene house and town lighting, operating at a pressure of from 3 to 6 inches water column (fractions of a pound per square inch).

With the advent of oxy-acetylene welding came the demand for a generator which would deliver gas at a higher pressure, and as a result various machines were placed on the market operating at pressures up to 15 pounds per square inch. The feed mechanisms are operated by devices which automatically stop the feeding of carbide when a desired pressure has been attained. The mechanism is safeguarded by suitable relief valves, water seals and flash-checks, all of which are fully prescribed by the National Board of Fire Underwriters.

Now that you may avoid the other fellow's mistake, and I regret to say in several cases, untimely end, it is well to point out several characteristics of acetylene gas, and their bearing on the apparatus designed to use it.

Acetylene in a free state at a pressure greater than two atmospheres, 29.4 pounds per square inch, is an unstable substance or one which may under a shock separate into its component parts. This separation or dissociation is of the nature of an explosion. The same occurs if a vessel of free acetylene under a pressure of two atmospheres is subjected to a heat of 1436 degrees Fahrenheit. It matters not if the heat be external to the vessel or a spark within it. The result is the immediate explosion of the entire volume of gas with the bursting of the containing vessel. It is not necessary that any air be present. Acetylene dissociates in the absence of air, the result being a violent explosion, providing the pressure be in excess of two atmospheres.

Acetylene is lighter than air, its specific gravity being .91. Therefore ventilate your rooms well by suitable ventilators in the roof or near the ceiling.

An explosive mixture is formed if only 3½ per cent of acetylene be mixed with the air of a room. Therefore never enter your generator room with an open flame or cigar.

These peculiarities of the gas have led to prescribing a limiting pressure of 15 pounds per square inch as the pressures under which generators may be operated. The National Board of Fire Underwriters seeing the necessity of some supervision over apparatus of this character, affecting as they would the fire risks, made exhaustive tests at their laboratories of various machines submitted and have approved several as fulfilling all requirements. The safest procedure therefore for any intending purchaser, is to insist that the generator he buys be one that has been passed by the National Board.

Purification

Acetylene delivered from the generator carries with it certain impurities, the removal of which is necessary. The principal ones are phosphoreted hydrogen and sulphurreted hydrogen. Just how harmful these impurities are in the making of the weld has never been clearly shown, but all compressed acetylene now being furnished is purified and virtually free from any impurities. In removing them chemical means are employed. A common form of purifier is here shown. The purifying material, which for this type of box is furnished in the form of a meal, is placed on the perforated bottom "A." Gas is admitted below this bottom and passes up through the purifying material "B" and out at "C." The cover is of the ordinary water seal type and the inner walls of the box in contact with the purifier are protected by several coats of acid-resisting paint.

The most common forms of purifier are Heratol, Frankolin, Puratyline and Acagine. Heratol is chromic acid absorbed in infusorial earth.

Frankolin cuprous chloride absorbed in a like man[illegible]

Puratylene is a specially treated mixture of ble[illegible]ing powder, calcium chloride and quick or slacked lime.

Acagine contains bleaching powder with lead chroma[illegible] and sometimes barium sulphate.

They all produce a commercially pure acetylene, a[illegible] the gas after passing the purifying boxes is suitable for bu[illegible]ing. For use in cylinders it is of the utmost importance th[illegible] the gas be thoroughly dried.

Drying

The usual materials used in drying are burnt lim[illegible] and calcium chloride. When lime is used a cylindrical or s[illegible]uare box is employed. This contains a series of trays with [illegible]rew bottoms placed one above the other. These trays are [illegible]lled with lump lime. As the gas passes up and through th[illegible] lime it gives up its moisture. The lime slackes and when spen[illegible] the trays are removed, the spent lime dust screened out and [illegible]resh lime supplied. It is not unusual to pass the gas through a similar device filled with calcium chloride, this secondary dryer placed directly after the lime dryers.

The gas is now commercially pure and dry and read[illegible] to pass to the compressor.

Compression

Compression of acetylene gas can only be safely accomplished in specially constructed compressors. Compression to 275 pounds per square inch in a single operation is attended with the evolution of a high degree of heat, not only injurious to the gas but highly dangerous. To overcome this difficulty three stage water cooled compressors were constructed. In this form of machine which employs a slow piston speed and a relatively large displacement, the gas leaves the first cylinder at a pressure of from 35 to 40 pounds per square inch, passes into an intercooler where the temperature of the first compression is reduced. It then passes to the second stage and leaves the second cylinder at about 80 pounds pressure. Again passing through an intercooler located between the second and third stages it enters the third stage cylinder and is delivered from this into a final cooler, jacketing the delivery pipe. By this method the gas is maintained at a very low temperature at all times.

These in brief are the steps taken in the preparation of the gas for delivery to the cylinders. There are certain precautions, which should be observed by all users of acetylene, whether they operate a complete compressing plant, a welding generator, or gas compressed in tanks.

Cylinders

Since it is unsafe to compress acetylene in a free state above 30 pounds per square inch, a specially constructed cylinder is employed for storage and transportation.

The Interstate Commerce Commission regulations give the following specifications for acetylene cylinders. "Cylinders containing acetylene gas must be made of tough steel and must be completely filled with a porous material that has been tested with satisfactory results by the Bureau of Explosives and this material must be charged with acetone or its equivalent, not to exceed 40 per cent of the interior volume capacity of the cylinder. The pressure in cylinders containing acetylene gas must not exceed 250 pounds per square inch at a temperature of 70 degrees Fahrenheit."

One of several methods of complying with the above consists in molding asbestos discs to exactly fit and fill the interior of the tank. These discs though they apparently fill the tank are from 75 to 80 per cent porous of its empty volume. The gas stored in these discs is not free gas and cannot be exploded by shock or heat. Flame or an explosive wave cannot be propagated through the finely divided asbestos. In addition to this a fusible plug is applied as at "A." If this cylinder gets in a fire the low melting solder (240 degrees Fahrenheit) of the plug melts and allows the gas to escape before a dangerous pressure has been reached.

The immense storage capacity is obtained by the use of acetone, a liquid much like alcohol. This liquid possesses the

power of absorbing and holding in solution 25 times its own volume of acetylene gas at 60 degrees Farenheit for each atmosphere of pressure.

Assuming that the cylinder was of two cubic feet empty capacity after the asbestos has been put in, 40 per cent of two cubic feet or eight cubic feet of acetone is forced into the tank. This is absorbed and held in the asbestos. For every atmosphere of pressure this acetone will hold at 60 degrees Fahrenheit 25 times its own volume of gas or .8x25=20 cubic feet of gas, and at 10 atmospheres. .8x25x10=200 Cubic Feet.

Temperature changes play an important part and cause fluctuations of the pressure. The hotter the day the higher the pressure and vice versa.

Don't attempt to check up the amount of gas you receive by the pressure. Gas is sold by weight, 1,000 cubic feet of acetylene weigh 69 pounds on a 60 degrees Fahrenheit basis. If you are billed for 200 cubic feet of gas you have received 13.8 pounds, and if you empty your tank at about 60 degrees Fahrenheit room temperature, you will get out of it 200 cubic feet. A thorough understanding of these facts will save a great many unwarranted disputes.

Acetylene tanks are made with the utmost care to withstand severe service, but they should be handled at all times with care, both in justice to the owner and to yourselves. The use of wrenches on the valves only delays your next shipment while valves are being replaced. Never forget you are handling an inflammable gas under high pressure and that your carelessness may affect the whole industry.

STREET RAILWAYS USE THREE PROCESSES

Among the first to adopt welding are always the firms which have a large production. The railroads and the street car systems are always on the lookout for methods of decreasing costs of repairs, or improvement of equipment to make it last longer.

In the laying of new rails the Chicago Surface Lines have standardized on a very heavy rail, laid on concrete. These rails, instead of being bolted together on the ends, are electrically welded. The method used is the pressure weld. The firm which does the welding is the Lorain Steel Company and the manufacturers of the welding machine is the Thomson Electric Welding Company of Lynn, Mass.

The equipment consists of a large oil transformer with flexible arms on the ends of which are attached electrodes which approach the joints from both sides at once in the form of a yoke.

These two arms are placed in position and brought together with the rail and the tie plates between them. Current is passed through the joint until the two become white hot. Flux is poured over the place where the two plates make a contact with the rail and when the proper welding heat is obtained, pressure is applied through a hydraulic jack and the heated metal between the two copper electrodes is compressed to make the weld. Three of these welds are made on each joint and they are said to be 100 per cent efficient.

Besides the car carrying the welder supported on a swinging crane, the outfit consists of a car carrying a grinding apparatus to smooth off the surface of the rail, and usually another car carrying a motor generator to enable the operators to use the commercial current or the current from the trolley wires.

REPAIRS BY ARC SYSTEM

The electric arc welding process is used by the Chicago Surface Lines for building up the corners and edges of the crossing frogs, where through the hammering of many hundreds of thousands of wheels per day the steel wears off, necessitating either a new frog or repair of the old one.

These repairs are made by an arc welder, which takes the current from the trolley wire and by means of resistance coils cuts it down to a lower voltage. The current is carried through a cable to a holder, used by the operator. This holder takes a welding rod of steel. When the welding rod is touched to the rail an arc is made, which causes the steel from the rod to drop off onto the rail, building it up in this way to somewhat more than the original height. The surplus is then ground off to a smooth finish and the frog is good for another six months or a year's year.

This process is used nightly between the hours of twelve midnight and five A. M. by a number of gangs of operators in different sections of the city, one gang operating in the loop district only. A screen is placed around the operator to prevent danger to the eyes of pedestrians and the operator himself wears a hood covering his whole head with special lenses to prevent the dangerous violet rays of the arc from blinding him.

A close record is kept of the length of wear given by these welds and their costs, and years of service for this method prove its usefulness and its saving of maintenance costs.

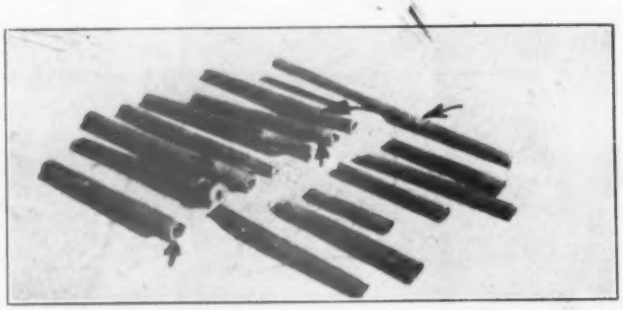
REPAIRS BY OXY-ACETYLENE SYSTEM

The oxy-acetylene system has been in use longer than any other in the shops of the Chicago Surface Lines. All kinds of repairs are accomplished by its use. The most interesting of the uses to which it is put is the building up of the bronze bearings used in the motors. These are of manganese bronze and are large castings weighing from ten to thirty pounds. When the motors are overhauled these bearings are taken out and sent to the machine shop where the operators build them up to their original depth. They are sent to the shapers where the surplus metal is removed and the bearings ground to fit the motor shafts. The saving is tremendous, as the cost of this grade of manganese bronze is high and a good remelted casting very difficult to obtain.

The apparatus used is mainly Davis-Bournonville Company's apparatus and both oxygen and acetylene are being used in cylinders. The welding of the hand rails and guard rails used on the platforms is one of the most noticeable forms in which the manufacturing of new parts is carried on by the oxy-acetylene method.

Considering the fact that an average of three thousand cars are in daily use in the city of Chicago and that a small saving on each one annually amounts to huge sums, the need is seen for every possible use of cost cutting methods, both in manufacture and in upkeep repair costs.

Any increase in the size of the United States army and navy will necessarily affect the welding trade. More gas will be required, for instance, both for welding and also for the aviation and other departments. It is understood that the government is already making plans for the future. Any decided increase in navy yard facilities will, of course, mean more welding and no doubt the army will be equipped with welding and cutting apparatus on much the same scale as the equipment now carried by European armies.



Welded Pipe Specimens Tested in Tension Tests.

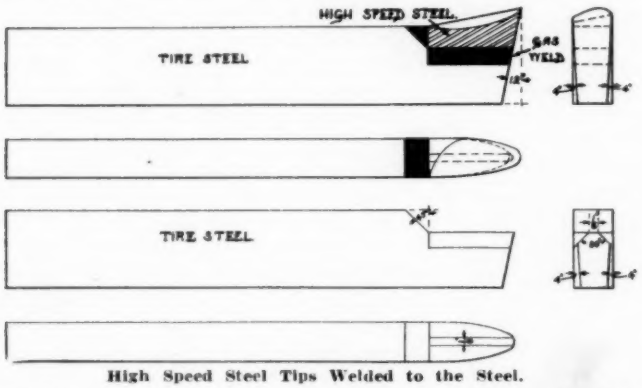
Welding Steel Tips on With Gas

An interesting article relating to the welding of high-speed steel to tire steel appeared in the Railway Journal for March, the article being written by E. J. McKernan, Supervisor of Tools, Santa Fe System, Topeka, Kans. The article was as follows:

"Wish to advise that we have been unlucky, just like all of our other railroad friends, being caught with a very small supply of high-speed steel when the extreme shortage took place. However, I will try to give you a detail explanation of what we are doing on the Santa Fe.

"We have experimented in many ways trying to weld high-speed steel tips on tire or carbon steel shanks, and we are pleased to say that we have now perfected the proposition to the extent that it is entirely satisfactory. We find that the only satisfactory method of welding high-speed steel to carbon steel is by the oxy-acetylene process. Our method is shown very plainly on sketch enclosed.

"It should be kept in mind that the carbon steel holders must be forged as per the sketch in order to get the best results. Also, it is necessary to forge up the high-speed steel tips as nearly the proper dimensions as possible before



High Speed Steel Tips Welded to the Steel.

weld is made. It is also found necessary to bring the high-speed steel tips up to about 2,200 degrees Fahrenheit and face the side that is welded to the carbon steel with Norway iron. In making the weld a good grade of special rolled steel must be used.

"When the parts are ready for welding the high-speed steel tip is placed in proper position on the carbon steel shank and welded with the oxy-acetylene gas at the points indicated in the sketch.

"It is found a good plan to have a large number of the carbon steel shanks made up, also the high-speed steel tips. This work is done in the blacksmith shops, but the welding is done by an expert gas welder. After the welding has been completed, it is necessary for the tool grinder to grind the tools to the proper shapes.

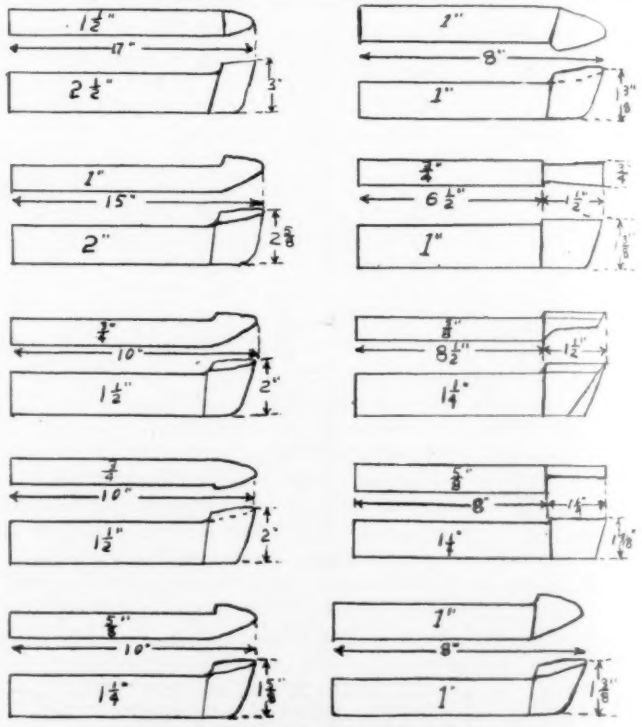
"Would advise that on our wheel lathes we have been able to turn out 250 pairs of coach wheels with a pair of tools which were 2"x3"x20". These tools have given excellent service and we are able to keep up the same speed as when we used the solid high-speed steel tools. Furthermore, we have had the tip break down on one of the tools which were welded and we took it to the blacksmith shop, having it redressed practically in the same manner as the solid high-speed steel tools. This was done successfully without the high-speed steel tip becoming loose on the carbon steel shank. We have had several cases of this kind to fill in each case the tool has been redressed in the blacksmith shop successfully.

"In order to redress these tools successfully, it has been found advantageous to draw the tool down underneath the part where the high-speed steel is welded. After this part of the tool has been drawn down to the extent of about ¼ inch below the bottom or parallel surface of the tool, place same under the steam hammer and strike a blow directly back of where the high-speed steel is welded to the shank. This will return the point of the tool to the proper place, giving it the proper shape, etc.

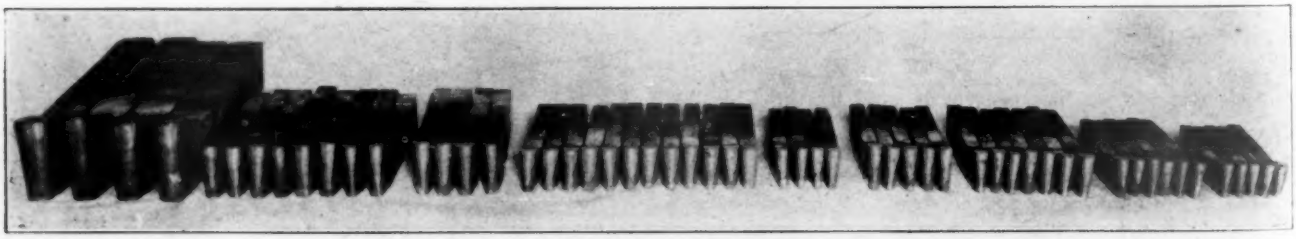
"We have adopted this plan over the entire system and it is giving us complete satisfaction so far. In other words, we would not know we were using a two-piece tool if we did not know we had welded it, for the job is so complete that it is practically impossible to tell where the tool is welded, and the performance of these tools is equally as good as that of the solid high-speed steel tools. I am attaching a photograph showing a group of tools that were welded in the above manner."

WELDING HIGH-SPEED STEEL TIPS ON TOOLS

The best method of welding high-speed steel tips to tools is causing considerable discussion. Henry Harris, blacksmith



Machine Tools Tipped With High Speed Steel.

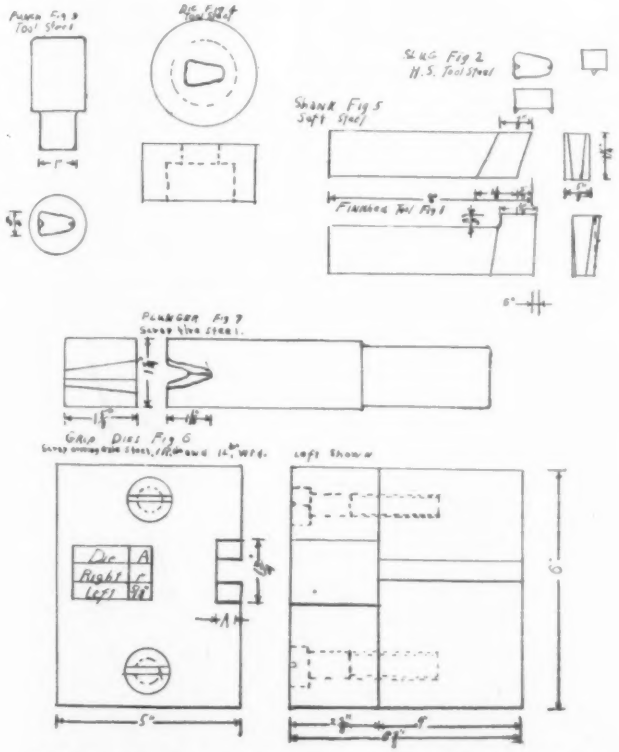


Some of the Finished Tools.

foreman for the Rock Island, Horton, Kansas, makes the following suggestion in the March issue of the Railway Journal:

"Enclosed find sketches and description of methods employed to weld high-speed steel tips or points on soft steel shanks for rough finishing, side and parting tools for lathes, planers, shapers, tire turning tools, etc.

"They are found as follows: Figure 2 shows the slugs punched hot from high-speed steel, varying in size from ⅜ to ⅞ inch in thickness, according to the size of tool to be made. Figure 3 shows punch used for this. The size shown in this sketch is for roughing tool ⅝ by 1¼ inch; other tools of different sizes are made on same plane. The punch shown in Figure 3 and the die shown in Figure 4 are used on the punch press. Wish to call attention to manner of making shearing edge of punch whereby a small pin is formed and later used in holding slug in place during welding. However, we have made hundreds of tools without the pin, merely drawing out the high-speed steel to width and thickness, knicking and breaking off and applying.



Method of Tipping Metal Cutting Tools With High Speed Steel.

"Soft steel shank is next tapered about the shape of high-speed steel tips, which is then heated in oil furnace to a white heat, covered with a welding compound; high-speed steel tip is applied cold with a light blow from a hand hammer, then returned to an oil furnace, heated to a welding heat, inserted in an Ajax forging machine in dies as shown in Figure 6. One revolution of the machine completes the tool. Figure 7 shows the plunger which does the work after tool is placed in the die.

"After the tool is taken from the forging machine it is thrust in a tank having about six to eight inches of oil on top of water, with the soft steel shank in water and the high-speed steel tip in oil. This tank is made with a drain to draw off hot water while cold water is running in at bottom, thus keeping oil and water cooled.

"If a tool should be a little too cool for tempering or hardening when taken from the forging machine, it should be reheated and then inserted in the tank. Any flash that is left thereon is knocked off when cooled. After grinding, the tool is ready for use.

"By making these tools this way there are several good advantages, I believe. By using the forging machine the work is done more economically, particularly when tools are made in large quantities. The intense pressure of the forging machine results in a very dense, close-grained tool being formed; and again, the forging machine method produces a better weld and a more uniform shaped tool; that is, it is superior to a hand-made tool. These tools have stood the most severe test in the Rock Island shops at Horton, Kans.

"The dies are made of scrap driving axles, and the plunger is made from scrap tires."

A FEW REGULATIONS YOU SHOULD KNOW

By H. P. Conreye, Special Agent

The Interstate Commerce Commission, under act of March 4th, 1909, prescribed, among others, regulations covering the transportation of compressed gases in interstate traffic by freight and by express. The enforcement of these regulations devolves upon the railroads.

In order to comply with this Federal law, the railroads organized "The Bureau for the safe transportation of explosives and other dangerous articles." It is headed by Col. B. W. Dunn, chief inspector, and comprises a corps of specially trained inspectors, ordnance, chemical and engineering experts, special laboratories, etc., in fact, all conveniences that will assist in the formulation of rules and regulations tending to safeguard the transportation of hazardous articles.

The Bureau has the support and co-operation of all manufacturers and shippers with the result that an excellent set of regulations is now in force under Interstate Commerce Law.

The manufacturers of compressed gases are making every effort to comply with these regulations. Certain labels are attached by the manufacturers to the cylinders, bills of lading carry complete description of the articles, the cylinders themselves are constructed and tested in specified ways; they are equipped with safety devices and safeguards as prescribed. In short, unusually harmonious co-operation has and does exist between the manufacturers, the Bureau, and the railroads.

The one link yet to be **welded** into this chain is the consumer. It is with the idea of concisely presenting to him his few obligations that I write this.

Under the law the railroads cannot transport an improperly described or improperly equipped gas tank. The shipper, in presenting it for shipment, is violating the law in the first place, and in the second place he is retarding the movement of these tanks. At the present time, when most gas manufacturers are struggling with the problem of supplying a sufficient number of tanks, the whole compressed gas industry feels the effect of delayed shipments.

Let us assume that the manufacturer has shipped you a tank, has complied with all the regulations and the shipment reaches its destination. It is now your duty under the law to remove this cylinder from the transportation company's property within forty-eight hours.

If this tank should be in a leaky condition, exhaust all the gas before shipping back. Do not ship a cylinder in a leaky condition. Remember, that the freight handler is the one endangered. Do not attempt to repair a valve for yourself; let the manufacturer do that. He knows how.

If you return a cylinder having in it gas with 25 pounds pressure per square inch or more, do not classify it as an **empty** tank. This is a violation of the law and the railroad men who must handle it are deceived by your classification. Describe it as a **charged** cylinder, and apply proper labels.

When returning an empty tank, classify it on your bill of lading as you **are requested to do by the manufacturer.** It is just as easy to call it an "Empty Acetylene Gas Cylinder,"

(Continued on Page 34)

Questions and Answers – Correspondence

The Welding Engineer is very glad to hear from the trade concerning problems to be solved or unique welding work which has been done. We shall be very glad to hear from those readers who disagree with, or have further light to throw on the solution of problems in this department — Editor

QUESTIONS AND ANSWERS

Editor: I recently welded a water jacket on an air compressor. It was frozen and cracked clean across the full length, about 3½ ft. I preheated it with a 6 in. diameter kerosene heater or Buckeye heater, but didn't seem to get it hot enough, as when I had it welded three-fourths the length it cracked where I had started.

How hot must it be before you can safely weld it?

The water jacket was cast iron.

Could you advise me through your journal the best and safest way to preheat and weld a job of this kind, and send me a copy? Also the subscription price, as I intend to subscribe for a year.

Thanking you in advance, I remain,

WM. MOELLER.

818 Dillingham Ave., Sheboygan, Wis.

Answer.—Your trouble in preheating the compressor casting was that you preheated it locally, and so introduced internal strains. This, of course, could not be avoided when using the means of preheating—a kerosene burner—which you had at hand.

The proper procedure in a case of this sort is to preheat the casting in a charcoal fire, taking care that it is preheated evenly. It should be heated to a cherry red. The easiest way to preheat such a casting is to build a brick oven around it, fill the oven and cover over the casting with charcoal and light the charcoal. The casting should be left in the preheating furnace while being welded. After the welding is completed a little more charcoal should be added and the casting brought to an even dark cherry and then covered over with asbestos or sheet iron and left to cool in the dying fire.—Editor.

Editor:

Q. 1. In a plain old-fashioned forge method of welding, with low carbon steel, what is the temperature of the steel when it is in a welding state?

Q. 2. How much can the steel vary in temperature, maximum and minimum, and what are the said temperatures, and still be in a welding state?

Q. 3. What is the relation between the temperature of the steel in the welding state and the required amount of force to make the weld—that is, blow or pressure?

If you have any positive information on this subject, we would appreciate getting it.

MORRIS W. KELLOGG.

The M. W. Kellogg Company, New York, N. Y.

A. 1. The welding temperature of low-carbon steel in making a forge weld is between 2600° and 2700° F.

A. 2. The steel will not vary any further than as indicated in question No. 1 if a proper weld is made.

A. 3. No definite data can be given on the relation between temperature and pressure. We can say, however, that if the steel is at the proper temperature, a comparatively light blow will produce a real weld. Of course a heavy blow will be required when heavy pieces are being welded, while a light one will be required when light pieces are being welded.

Editor:

The other day I was cutting up a boiler here in Grand Rapids. It was very cold and windy, being about 2° above zero, and my gases were freezing fast and I was wondering how to overcome this difficulty. I went to a livery barn not far away and got a lot of manure which was warm and put it around the tanks. I had no trouble after that all day. I also noticed that while cutting outside in the cold that by giving your preheating flame just a little excess of acetylene you can get better results and cut faster. I also kept a charcoal fire in a can beneath the oxygen regulator, which helped also.

G. L. GUNTHER.

Grand Rapids, Mich.

Answer: The trouble you speak of could not be due to the gas freezing—acetylene gas dissolved in acetone will not freeze at a higher temperature than —80° centigrade (112° below zero Fahrenheit). Neither will oxygen, as commercially dispensed, freeze under the conditions you mention. Your drop in pressure was due partly to gas being emitted from the tanks and partly by contraction due to the low temperature, if your cylinders had been stored in a room at 50° to 70° F. and then removed to the outside where 2° above prevailed you would soon notice a considerable drop in pressure.

Another thing possible, but not probable under conditions you mention, is the "freezing" of the ports in your valves or regulators due to friction of the gases.—Editor.

Editor:

For my own information kindly write me a personal letter how to make a cutting test between electrolytic oxygen, air oxygen and other grades of oxygens, such as the difference in consumption of gases by foot, the difference in cutting pressure each grade of gas will cut at, and cost.

J. R. B.

Answer: The only positive way to test the comparative value of electrolytic and liquefaction oxygen is by a practical laboratory test using a gas-bell and meter, cutting metals that are identical and using the same torch for all tests. This will give you the relative oxidizing effects, pressure and costs. —Editor.

Editor:

Why does the arc from our arc welder burn a hole in sheet steel when the operator draws the arc? We have a 75-volt, 150 ampere welder with a motor generator set installed on a portable four-wheeled truck. Our power is 220-volt alternating current. Also what colors of lenses should be used in an arc welding helmet?

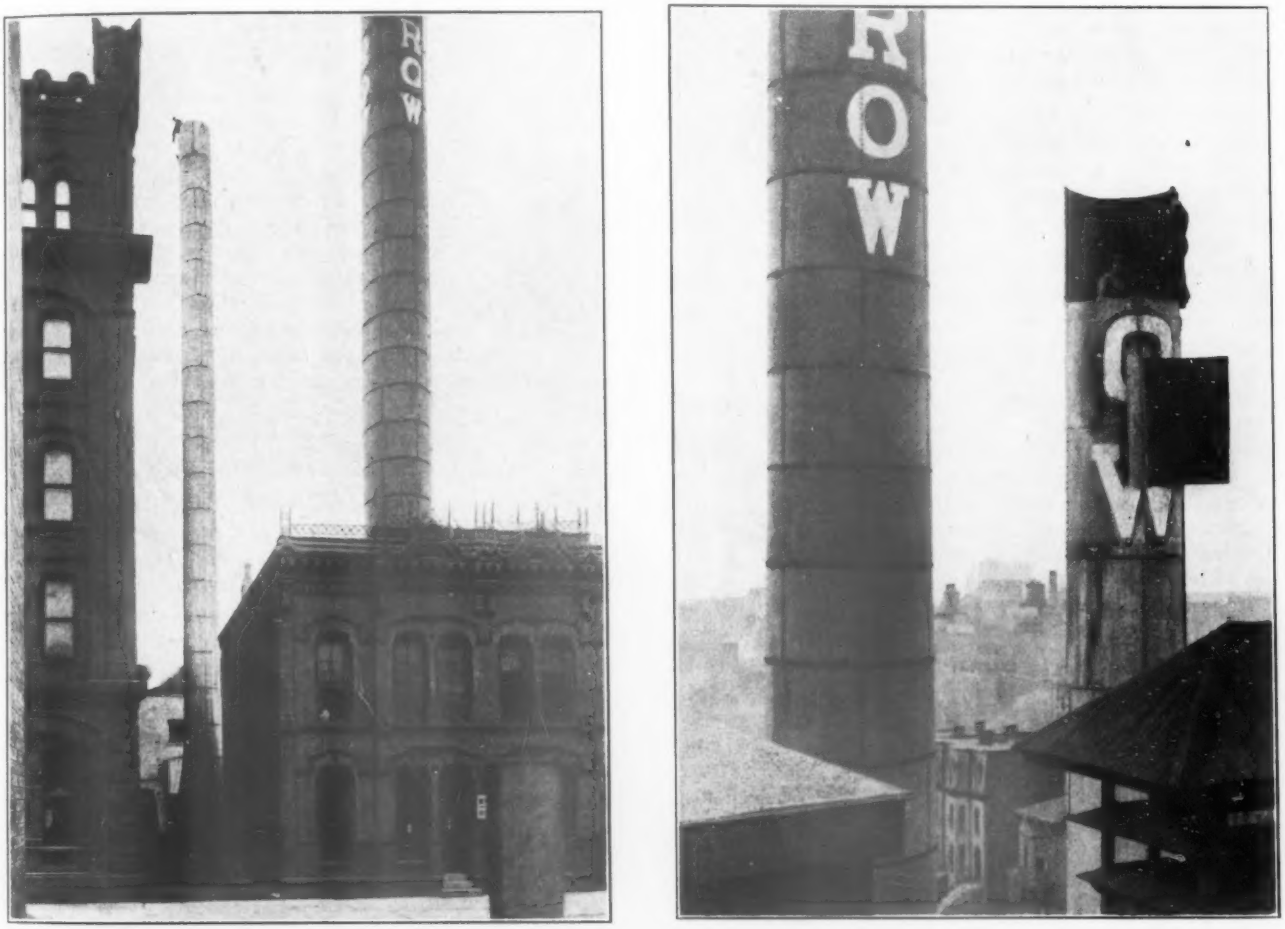
E. H. POTTER.

Answer: The reason for the burning of the steel on the making of the arc is caused by the fact that the full voltage is used in the making of the arc. On some makes of machines this is taken care of by automatic switches, which one by one throw in the power, building it up by degrees until the maximum voltage is obtained. These automatic switches are rather delicate and, being mounted on the truck itself, are prevented from working most efficiently by the vibration

caused by the motor and generator. When the truck is set on a dirt floor the machine shakes more than when set on a concrete floor. The newest machines are constructed with a so-called variable voltage generator, which by means of shunt windings through the field and armature keep the voltage down to about five volts when the the arc is struck, increasing the voltage as the arc is drawn longer. This method saves current, prevents burning and is much easier on the operator. If you have the automatic switches on your machine, steady it by putting it on a concrete floor or block wheels with stones or bricks. If you have one without, have an electrician look at the connections and test the generator windings for short circuits. A deep red, a light olive green and a clear white lens makes the ideal combination. The clear lens goes on the outside and when broken or covered with steel is replaced. The deep red lens cuts out the density of the light while the green cuts out the ultra-violet and the infra red, both harmful rays. The only way to test glass is by use of a spectroscope machine which throws light from an arc on sensitized paper. According to our custom we are sending you the name of the manufacturer under separate cover.

Editor: I notice in the February issue one or two references to malleable iron, and in the January issue a short article on what is there called malleable iron. In the February issue on page 28 in your "Questions and Answers Department" these references to malleable iron occur, and on page 18 of your January issue is the article on malleable iron that I refer to. This latter article uses the term malleable iron as it is used in Great Britain. This material in this country is called wrought iron. In this country so-called malleable iron is the same material as is called in Great Britain malleable cast iron. Care should, therefore, be taken not to confuse the two materials.

If the manufacture and nature of malleable iron were understood by all welding shops, no attempt would be made to weld it with cast iron or Norway iron. There are two kinds of malleable cast iron, the nature of each depending on the process of manufacture. They are both made from chilled iron castings, the carbon in which is all in the form known as combined carbon, or carbide of iron, a very white and intensely hard brittle alloy of carbon and iron. The process generally used in Great Britain and on the Continent is what is known as the white heart process, which removes sufficient of the carbon from the casting to make it a crude steel and this carbon is removed entirely throughout the casting. Such castings can be welded with Norway iron. In the United States, however, the process used produces entirely different material, the carbon not being removed, except from the outer shell, while in the interior it is converted into another form known as temper carbon, which is exactly the same as graphite in ordinary gray cast iron, the form in which it occurs, however, being rounded masses instead of plates, as in gray cast iron, the percentage of carbon and the other elements in the interior being the same as in the original chilled iron casting. It is evident that if it is melted it will return to its original condition, which is hard and brittle, and inasmuch as cast iron cannot be welded with Norway iron, it is useless to attempt welding such malleable iron with Norway iron. The welding can be done with cast iron, but the weld will only have the strength of the cast iron, and next to the weld the metal will be hard and brittle. The reason why Tobin bronze or manganese bronze is used for welding malleable iron is that it is not necessary to bring the malleable iron to the



Steeple Jacks, Reynolds and Vellens, Cutting Down a Huge Stack With Oxy-Acetylene Apparatus. This work was described in our February issue.

melting temperature, the bronze alloying with the iron below this point.

With regard to welding automobile drive shafts or differential shafts referred to in your February issue, it should not be forgotten that many of these axles are made of alloy steel and that none of them, to the writer's knowledge, are made of steel with less than .4% carbon, also that any oxy-acetylene weld is only a casting. It is impossible to make a casting as strong as a forging. Therefore, one should not be surprised if the weld fails. The writer believes it impossible to weld high carbon steel without burning it, and the higher the carbon, the greater the danger for two reasons. The steel is partly decarbonized and is always burnt, the writer believes, next to the weld. Microscopical examination of such welds proves this. The conditions while welding are entirely different from those that take place during the manufacture of steel, the result being that the oxygen from the air penetrates the steel while welding and forms films of oxide around the grains, which cannot be removed, and which makes the steel weak and brittle. It is true that such a weld may be at times strong enough to stand the strain to which it is subjected, but it is not a perfect job by any means, no matter what precautions may be taken.

With regard to welding automobile springs the previous remarks apply, and while it is at times possible to produce a satisfactory job on springs, there is always the chance that the work will be unsatisfactory. The most important thing, however, in welding any grade of steel is that the heat changes the structure in the vicinity of the weld, making it weaker than the original material. This is solely the result of the heat applied, and is due to the fact that any piece of steel heated in any way above a certain point becomes coarser in structure and therefore is less strong. This can be overcome partly by heat treatment after the welding operation is finished, but the original strength and other physical qualities can never be entirely restored. If the above facts are kept in mind, many of the apparently mysterious failures of steel welds can be readily accounted for, and certain work which the writer believes to be dangerous will not be attempted. As an illustration, the welding of steering knuckle spindle to the body of the knuckle is a job which he does not permit done in his shops, as no reinforcement can be made, and the weld is necessarily weaker than the original material, which involves possible danger to life.

In conclusion, I want to compliment The Welding Engineer on its desire to get accurate and complete information, and I wish it every success. The articles in it are worthy of serious consideration and give a great deal of valuable information.

S. W. MILLER, M. E.

Rochester Welding Works, Rochester, N. Y.

Editor: There are a number of things which I have noticed in the first two issues, which could be seriously criticized as misstatements of facts. As an illustration of what I mean, on page 33 of the January issue the statement is made that a welding rod of the same material as the piece to be welded should be used. Directly under this the statement is made that a good welding rod should melt at a lower temperature than the rod. If it is of the same composition, it will melt at the same temperature. Earlier in the same article steel having a melting point of 1800° F. is spoken of. There is no steel that melts at this temperature. Steel having 1½% carbon is completely melted at about 2550° F. and on cooling solidifies completely at about 2200° F. This is a much higher carbon steel than is used in practice, except in rare instances. The temperature of melted steel during manufacture is very much higher than this. The real reason for steel not being burnt during manufacture is given by Howe in his work on iron, steel and other alloys and is too long to quote here.

Another statement made in the same article speaks of silicon in cast iron rods and phosphorus in bronze as being fluxes. In neither case is this correct. A large amount of silicon is added to cast iron welding rods for the purpose of promoting the formation of graphite, which makes the weld soft. In the case of bronze, phosphorus is used as a deoxidizer.

I do not feel that it is necessary to call public attention to these errors, but I bring them to your personal attention, as I hope to see your paper as accurate in all respects as it is in the most of them.

S. W. MILLER, M. E.

Rochester Welding Works, Rochester, N. Y.

Answer: We are glad to publish Mr. Miller's two letters as we feel that any misstatement of facts should be corrected. Constructive criticism is very welcome and we thank Mr. Miller for his trouble.—Editor.

A FEW REGULATIONS YOU SHOULD KNOW

(Continued from Page 31)

or an "Empty Oxygen Gas Cylinder," as it is to call it an "Empty Air Drum," an "Empty Iron Tank," or any of the numerous misclassifications so well known to gas manufacturers. Misclassification **usually costs you more money**, for you pay a higher rate.

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WELL KNOWN SCHOOL PREPARES FOR WELDING COURSE

The scarcity of schools for welding which has before been mentioned in our editorial columns seems about to be broken.

Armour Institute of Technology, one of the best schools of its kind in the United States, though not as large as some, has installed an oxy-acetylene apparatus, manufactured by the Oxweld Acetylene Company.

The machine is their standard welding machine mounted on a truck and is installed in the laboratory building at 35th and Federal Streets, which building contains also the forge department. In this department general blacksmithing, foundry, machine and pattern work are also being taught. Professor G. F. Gebhardt, head of the mechanical department, has charge of classes in these lines. Mr. William Smith, of the school, is preparing to demonstrate the use of the apparatus.

The school is well equipped with all kinds of steam and electrical machinery, all of it in actual operation for the benefit of the students, many of whom in the past, after obtaining their degrees as mechanical or electrical engineers, have become a part of the engineering world and are heard of in the most remote parts of foreign countries.

Many inquiries as to where to obtain instruction in welding seem now to be in a fair way to be answered, as the Armour Institute is a well known technical school. No classes have been formed as yet, an instructor being one of the first requisites, but as there are several students in the night classes who are employed as welders during the day, no doubt no difficulty will be found in that line. The machine will demonstrate its worth right along on the school's own work and the welding department may grow to great proportions.

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Trade News

On page 20 of The Welding Engineer for February we published an illustration showing the work which was being done on fourteen marine boilers which were cut out in St. Louis recently. We understand that of these fourteen boilers, seven of them were cut out by the Atlas Welding & Cutting Company of St. Louis, who used Henderson-Willis welding and cutting apparatus exclusively. Seven of the boilers were also cut out by the Graham Welding Company, also a St. Louis concern, who use Messer apparatus mainly.

The Superior Oxy-Acetylene Machine Company of Hamilton, Ohio, have just issued a new catalog describing welding and cutting equipment and supplies. This company has succeeded in bringing out the longest cast iron welding rods that it is possible to cast being 24 in. to 30 in. long.

The Compressed Gas Company, Ltd., Vancouver, B. C., have worked out a formula which is said to be very helpful in welding aluminum. The formula is advertised elsewhere in this issue.

An interesting exhibition was held at the Coliseum, Chicago, March 1st to 12th, the occasion being the Panama-Pacific Medal Winners' Exposition. Among the exhibitors was the Davis-Bournonville Company, whose display attracted much attention. It consisted of the various welding and cutting torches manufactured by the company, as well as generator outfits and supplies. The Oxygraph, a special cutting machine, amazed the passing throng and was probably the most interesting piece of machinery at the show.

The Henderson-Willis Welding and Cutting Co., St. Louis, have purchased a four-story building at Eleventh and North Market Streets and will move the factory to that location the latter part of the month. This move is to take care of a rapidly growing business and the old office and plant at 2826 Locust Street, will be retained.

Mr. P. F. Willis, of the Henderson-Willis Welding and Cutting Co., St. Louis, will read a paper on March 21st before the conference of the Bankers' Association of the Central States at Chicago on the use of the oxy-acetylene cutting torch and its effect on safes.

THE VILLAGE BLACKSMITH

(Modern)

Under the spreading chestnut tree,
  The modern smithy stands.
The welder, a peculiar man is he,
  That wields the magic wand.
His ability to fix the broken things,
  You can hardly understand.

His hair is mussed and black and long,
  His face is black as coal,
His brow is wet with honest sweat,
  His clothes are full of holes;
He looks the whole world in the face,
  He has never stalled yet, we are told.

Week in, week out, from morn till night,
  The broken things roll in.
Machinery and tools, stove legs and such,
  And funny-looking castings galore;
But none of them worry the man with the torch,
  He has worked them all before.

The people, as they hurry to and fro by his place
  Glance in through the open door.
They love to see him burn his face,
  And hear him swear and roar,
While he kicks around in asbestos dust,
  That covers the entire floor.

He goes on Sunday to the garage,
  Cranks up his old tin "flivver."
He hikes to the country, with a smile and a song,
  And lays by the quiet river,
And dreams of the days that are past and gone,
  While his heart is caught in a quiver.

He dreams of the days down on the farm,
  When life was young and gay.
He needs but think of them once more,
  And O what a change from that day.
Nothing is like it used to be,
  And ne'er will be again, so they say.

Welding, cutting and brazing,
  Onward through life he goes.
Each day a new task confronts him,
  Each evening his muscles are sore.
And he heaves a big sigh of comfort,
  As he discards his fighting clothes.

Thanks, thanks, to thee, my worthy friend,
  For the lesson thou hast taught.
We no longer worry of the long delays,
  Our breakdowns to you will be brought;
And thus with your mighty welding torch,
  Our lesson from you has been taught.

G. F. KING

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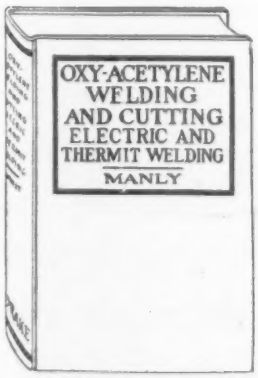
Oxy-Acetylene Welding and Cutting
Electric and Thermit Welding

By HAROLD P. MANLY

Chief Engineer American Bureau of Engineering



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ALUMINUM WELDING

By Harry B. Hoover, Oxy-Acetylene Engineer

Aluminum is the hardest metal to learn to weld, but is the easiest to weld after learning. There are different methods of welding aluminum, but the writer, after several years of successful aluminum welding, has found that the following way is the most successful and practical method.

Some of the most difficult things to overcome and contend with in aluminum welding are the rapid oxidization of the metal, the low point of fusion, the rapid conduction of heat, the contraction and expansion, the shrinkage, and in automobile parts the chances of warping to keep the piece in perfect alignment is one of the most important things.

Oxidization

Aluminum oxidizes very rapidly under the welding flame, the oxidization forms a film or skin over the molten metal and prevents it from flowing together as freely as other metals, such as iron and steel. The oxide melts at a much higher temperature than the metal. This action of the oxide makes it somewhat troublesome for the beginner to weld aluminum. The chemical inertia of the oxide makes it exceedingly difficult to decompose with the flux, even at the temperature of melting aluminum.

Fluxes for this purpose, therefore, have to be very strong and chemically active, and one disadvantage of most fluxes that the writer has used is the after-action on the aluminum. In many cases the metal has been seriously injured by this action, although it took some time for the damage to develop. After the welding is done, the piece must be thoroughly brushed in boiling water to remove remnants of the flux and prevent this action.

It is also the writer's experience that after a weld has been made with a flux, should a crack develop in or near it, such a crack cannot be welded without considerable difficulty. It cannot be welded at all unless the surface is thoroughly cleaned and the metal in the old weld has been removed.

While it is theoretically advisable to use a flux, and in case of sheet aluminum it is necessary to do so, there are other reasons than above mentioned. In the case of repairs to castings, such as automobile crank cases, transmission cases, etc., the use of a flux is difficult. The principal difficulty is found in the condition of the surface before welding.

It must be remembered that before any flux can be used, the surface must be entirely and thoroughly cleaned.

Frequently, it is not possible to do this, although the use use of strong acid and alkali, such as hydrochloric acid and caustic soda (applied to the work separately), followed by a thorough washing and brushing in hot water afterwards, will remove the dirt and grease from the exposed surfaces. It will not however, remove the oxide, nor, as a general rule, will it remove the grease and dirt from the crack or break, because they are more or less absorbed by the aluminum, which is porous.

This absorption extends in from the break for some distance in some cases, and unless such metal is entirely cut out, the use of flux will be found unsatisfactory. The narrower the weld, the less the contraction and distortion of the piece, and so the less metal removed the better.

Sheet aluminum work is generally a manufacturing proposition and a flux is necessary for the proper performance of the work, but as the surfaces are clean, the same objections to a flux do not exist as in the case of broken parts, and the flux will make the weld just as tough and strong as the original sheet. A very small amount of flux is all that is required with clean metal, but it must be remembered that the flux must be washed off as above mentioned. It is, however, open to the objections previously explained.

In most cases a weld can be made without the use of a flux in the time taken to prepare the piece, so that a flux can be used.

Puddling System

For practical purposes, the puddling system is far the best, this being accomplished by the use of a paddle (a small steel rod flattened on one end and ground or filed off smooth and made like a flat scraper or screw driver; the edges must be sharp).

Aluminum, unlike other metals, does not change color when it becomes hot, as does steel and iron. This makes it necessary to watch it very closely and when the edges begin to fuse use the paddle to puddle them together.

First, take the paddle edgewise and force it down into the molten metal along the crack or break and be sure that the metal is being welded entirely through. (Care must be taken not to get the paddle more than red hot.) Now the filler rod is used to fill up the deficiencies. Keep the metal molting and rub the end of the filler rod into the weld, allowing the flame to come in contact with the rod and the weld at the same time. The rubbing of the rod in the molten metal keeps the oxide broken up and allows the metal to flow together. After enough metal is added from the filler rod the paddle is again brought into use, this time using the flat side to smooth the weld and rub off the surplus metal.

The paddle must be kept warm, clean and smooth all of the time. If it gets too hot, so that it partly melts, replace it with a new one. A number of these should be kept on hand.

A weld made in this way will be just as solid and strong as any other part of the metal, and if care is taken it can be made as smooth as any other part of the casting.

(To be continued.)

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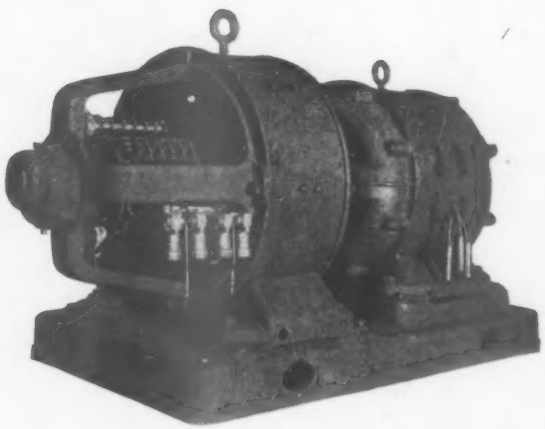


ARC-WELDING MOTOR-GENERATOR SET. ARRANGED TO SUPPLY SEVERAL OPERATORS SIMULTANEOUSLY AT DIFFERENT PLACES.

When you install electric arc welding equipment to lower your welding repair costs, be sure to get the equipment that will best fulfill all your needs.

Remember:

The system which is most flexible is the one which will best do your work. You may want to use several operators and the full welding capacity on one rush job, or you may need considerable power on several jobs at the same time. You want power **when** you want it, **where** you want it, and at a minimum total cost.

A single delay due to lack of power **at the required place** is likely to cost you more than any saving you may be able to make by the use of smaller equipment.

Westinghouse Arc Welding Equipments

are the most flexible and at the same time the simplest. The apparatus is of standard design and construction throughout. Hence this flexibility is obtained at low cost, for the equipment, the installation and the operative.

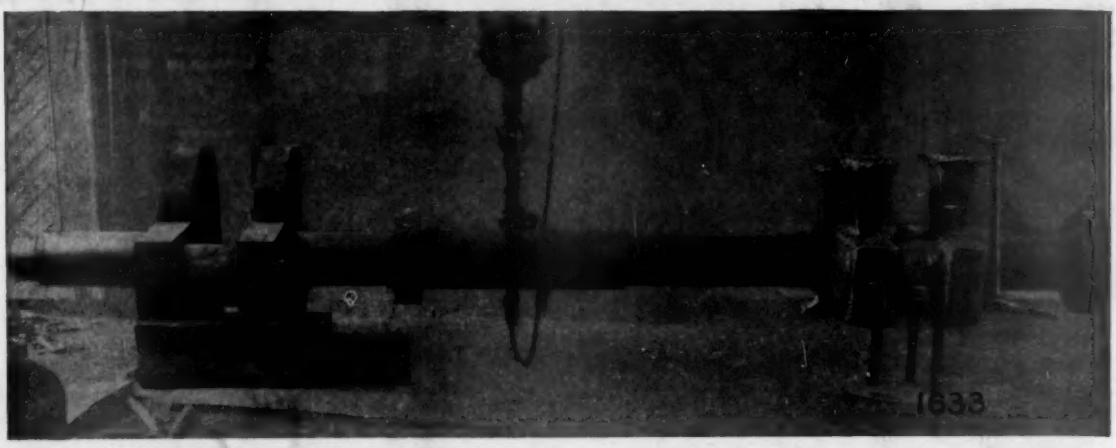
It'll pay you to investigate what other companies are doing.

Westinghouse Electric & Manufacturing Co.

East Pittsburgh, Pa.

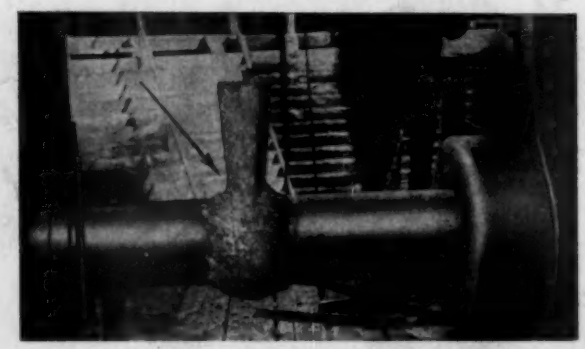
Atlanta, Ga.	Charlotte, N. C.	Denver, Colo.	Louisville, Ky.	Omaha, Neb.	San Francisco, Cal.
Baltimore, Md.	Chicago, Ill.	Detroit, Mich.	Los Angeles, Cal.	Philadelphia, Pa.	Seattle, Wash.
Birmingham, Ala.	Cincinnati, Ohio.	*El Paso, Tex.	Memphis, Tenn.	Pittsburgh, Pa.	Syracuse, N. Y.
Bluefield, W. Va.	Cleveland, Ohio.	*Houston, Tex.	Milwaukee, Wis.	Portland, Ore.	Toledo, Ohio.
Boston, Mass.	Columbus, Ohio.	Indianapolis, Ind.	Minneapolis, Minn.	Rochester, N. Y.	Washington, D. C.
Buffalo, N. Y.	*Dallas, Texas.	Joplin, Mo.	New Orleans, La.	St. Louis, Mo.	*W. & E. Co., of Texas.
Butte, Mont.	Dayton, Ohio.	Kansas City, Mo.	New York, N. Y.	Salt Lake City, Utah	
Charleston, W. Va.					

Say Welding—Think Westinghouse



Thermit Welds on 8½-in. Crankshaft. Two new webs and a crank pin were welded in one operation

Large Dredge Dipper welded with Thermit before trimming



11-in. Tail Shaft welded for steamship without removing it from vessel

The Thermit Welding Process Is the ONLY One That Will Give You a Permanent Repair on Wrought Iron and Steel Sections

WHAT THERMIT IS

Thermit is a mixture of granulated aluminum and iron oxide which, when ignited, reacts, producing superheated liquid steel at a temperature of 5400 degrees F.

HOW WELDS ARE MADE

A broken section is lined up and a mold built around the fracture. The fracture is brought to a red heat by a special preheater and the Thermit mixture is placed in a special crucible so that when the Thermit reaction is over, the liquid steel can be poured from the bottom of the crucible into the mold, and being at such a high temperature, is sufficiently hot to melt the sections with which it comes in contact and amalgamate with them to form a solid mass when cool.

Broken crank shafts, mine hoist shafts, gear wheels, fly wheels, dredge sections, engine frames, rock crusher shafts, and many other heavy sections, can be restored to service in one or two days at slight expense and often effect a saving of thousands of dollars in time and repair costs.

When you realize the advantages to be derived from use of Thermit for repairs you will install the process at once.

Write for Bulletin No. 1779

GOLDSCHMIDT THERMIT CO.

WILLIAM C. CUNTZ, General Manager

90 WEST STREET, NEW YORK

329-333 Folsom St., San Francisco 7300 So. Chicago Ave., Chicago
103 Richmond St., W., Toronto, Ont.

Crankshaft machined and ready for service. The arrow points to location of Thermit welds